DESIGN CRITERIA
Table of Contents

LIST OF DESIGN AIDS

PROCEDURE FOR
PUBLIC IMPROVEMENT PROJECT PLAN SUBMITTAL

All developers and engineering consultants submitting plans for public improvement projects to the County for review are required to follow the procedures outlined in the following. No public improvement projects may be constructed in the unincorporated areas of Clay County without the prior approval of the County Engineer, the Clay County Commission and the Clay County Planning and Zoning, where applicable.

1. Three complete sets of prints of the project plans shall be submitted to the office of the County Engineer for review.

2. Upon receipt by the County, the checkprints will be date stamped and assigned project number.

3. The normal time for review shall be ten (10) working days. In the case of abnormally large sets of prints (greater than twenty (20) sheets) or of extremely complicated drawings, a longer time may be required for review.

4. The checkprints will be routed through appropriate County departments and/or divisions to obtain a complete review of all facilities which may be affected by the proposed construction. In each review, comments and necessary revisions will be noted on the checkprints.

5. Subsequent to the review of the plans, the consultant or his representative shall be notified by telephone that the submittal is ready for return.

6. The consultant will be required to make all necessary corrections or revisions as noted on the checksets. Upon completion of the revisions and/or corrections the plans will again be submitted to the County Engineer's office for further review. Revised sheets submitted shall contain a revision block with identifying notations and date of revisions. <u>All previous checksets must accompany each re-submittal. If the checksets are not submitted with the revised drawings, the plans shall be returned to the consultant without action until such time as the checksets are included with the submittal</u>.

7. In conjunction with submittal of final plans, all permits and/or applications for permits, shall be submitted to the appropriate agency for approval prior to final approval of the plans by the County Engineer (i.e., State Highway Department, Department of Natural Resources, etc.).

8. The length of time for final plan approval will normally be within ten (10) to twenty (20) working days. Upon notification of final approval of the plans by the County Engineer, the number of sets of plans as specified in the appropriate section of the Design Criteria Manual shall be submitted for signing and distribution.

9. A Vellum sheet or (saved on computer disk) of the title sheet shall accompany the submittal of plans for final approval by the County Engineer. The County Engineer shall sign and date the mylar cover sheet serving as the County's approval. Then the mylar sheet is submitted to the Clay County Commission for signatures. This mylar sheet shall be returned to the consultant and shall be utilized for all further cover sheets in bid documents sent out for proposals.

10. Public improvement plans and engineering reports are approved initially for one (1) year after the date noted on the returned cover sheet. After one (1) year, the plans or report shall become null and void and must be re-submitted prior to approval of construction of that project. Such plans and/or reports shall be re-submitted to the office of the County Engineer in accordance with the foregoing outlined procedures and requirements.

11. The Design Engineer shall send one set of plans to each of the private and public utility companies having territorial jurisdiction in the area of the improvement upon notification that the drawings have been approved.

12. Extension of time: If a period of two (2) years has elapsed from the date of the start of any construction of streets or roads in any subdivision, and project has not been completed enough to be approved for the contractor's and/or developer's two (2) year maintenance period the contractor and/or developer, must request an extension in writing of construction time (not to exceed one (1) year) or appear in person before the County Commission.

A. GENERAL. All plans and reports submitted shall be prepared by, or under the direction of, a professional engineer, licensed in the State of Missouri, and shall be reviewed by the County Engineer for compliance with the minimum design requirements as established in the Design Criteria Manual for Public Improvement Projects of the Clay County Highway Department/PWD and with all other applicable County codes and standards.

Attention is directed to the design engineer that whenever extraordinary or unusual problems are encountered in conjunction with a proposed project, additional information and analysis beyond the minimum requirements of these standards and criteria will be required.

The Clay County Highway Department/PWD is not responsible for the accuracy and the adequacy of the design or dimensions and elevations as depicted on the plans (which shall be confirmed and correlated at the site of the work by the contractor and/or developer). The Clay County Highway Department/PWD, through the approval of the plans and/or report, assumes no responsibility for the completeness and/or accuracy of the public improvement plan or report.

B. REQUIRED NOTES GENERAL. The following general notes will be required as a minimum on all plan submittals for public improvement projects. These notes are not meant to be all-inclusive and in certain situations the use of additional notes may be required by the Engineer.

1. Development plans are approved initially for one (1) year after which they automatically become void and must be updated and re-approved by the County Engineer before any construction will be permitted.

2. The Clay County Highway Department/PWD plan review is only for general conformance with Clay County Highway Department/PWD Design Criteria and the County Code. The County is not responsible for the accuracy and adequacy of the design, or dimensions and elevations, which shall be confirmed and correlated at the job site by the contractor and/or developer. The Clay County Highway Department/PWD, through approval of this document, assumes no responsibility other than that as stated above for the completeness and/or accuracy of this document.

3. The contractor and/or developer shall have one (1) signed copy of the plans (approved by the Clay County Highway Department/PWD) and one (1) copy of the appropriate Construction Standards and Specifications at the job site at all times.

4. Construction of the improvements shown or implied by this set of drawings shall not be initiated or any part thereof undertaken until the County Engineer is notified of such intent, and all required and properly executed bonds and permit fees are received and approved by the County Engineer and the Clay County Commission.

5. The Clay County Highway Department/PWD Technical Specifications, latest edition, shall govern construction of this project.

6. All existing utilities indicated on the drawings must be according to the best information available to the Design Engineer; however, all utilities actually existing may not be shown. Utilities damaged through the negligence of the contractor and/or developer to obtain the location of same, shall be repaired or replaced by the contractor and/or developer at his or her expense. The contractor and/or developer shall call 1-800-DIG-RITE before attempting any excavation.

7. All backfill shall be tamped and at the option of the County Engineer tested by a certified laboratory.

8. Contractor and/or developer shall not be allowed to work on Saturdays, Sundays or Holiday without prior approval by the County Engineer.

9. All materials and workmanship associated with this project shall be subject to inspection by the Clay County Highway Department/PWD. The Clay County Highway Department/PWD reserves the right to accept or reject any such materials and workmanship that does not conform to the Clay County Highway Department/PWD Standards and Technical Specifications.

   The contractor and/or developer shall notify the Clay County Highway Department/PWD Engineering Services Department twenty-four (24) hours prior to the beginning of construction.

10. Relocation of any water line, sewer line or service line thereof required for the construction of this project shall be the responsibility of the contractor and/or developer at his/her expense.

C. REQUIRED NOTES INDIVIDUAL

1. WATER:

   a. The proposed water line improvements shown by this set of drawings have been designed to provide for the following fire flow requirements as determined by Clay County Regulations. (Note to be placed on development drawings that contain areas zoned for higher densities than R-2).

2. SANITARY SEWER:

   a. All sanitary stublines shall be laid on 2.00 percent grade unless approved otherwise.

   b. XXX denotes Minimum Basement Floor Elevation.

   c. The Contractor and/or developer shall install and properly maintain a

mechanical plug at all connection points with existing lines until such time that the new line is tested and approved.

3. STREETS AND STORM DRAINAGE

a. All sidewalks shown are for information purposes only. Sidewalks shall not be built as a part of this project unless streets are collector or arterial.

b. All compactions shall be performed as set forth in the Technical Specifications. All testing laboratory expenses shall be paid for by the contractor and/or developer.

D. APPROVAL BLOCK. A signature block shall be required on the cover sheet of all plans and reports submitted for review and approval. All plans require the signature of the County Engineer and the date of such signing for formal approval by the County.

The general form of the approval block shall be as follows:

APPROVED

_____ _____

Clay County Presiding Commissioner Date

_____ _____

Clay County Engineer/Highway Administrator Date

APPROVED FOR ONE YEAR FROM THIS DATE

E. PRIVATE IMPROVEMENTS. Private improvements, if any, shown on public improvement plans, shall be clearly defined and marked as such. These improvements will not be maintained by Clay County and, as such, an appropriate note shall be included on the drawings.

A. INTRODUCTION. The following criteria is being established to provide a uniform system of plan preparation that will aid the Design Engineer in preparing plans for work within the Clay County Highway Department/PWD maintenance system. It is not intended that the criteria be an iron-clad set of rules that would restrict the Design Engineer from utilizing imaginative design; however, all items as described below shall be shown on the plans in some manner.

B. GENERAL. All plans and specification for public improvement construction within either publicly-financed or privately-financed developments shall be prepared by a professional engineer licensed in the State of Missouri and submitted to the office of the County Engineer for review. Subsequent to the review, the engineer will be notified of the approval of the plans as submitted, or of any necessary changes. (Refer to the section "Public Improvement Project Plan Submittal" for plan review procedures.)

Upon completion of the review and approval of the plans by the County Engineer, three (3) sets of plans (as approved) must be submitted.

In addition, one set of approved plans shall be sent to each of the utility companies providing service in the proposed construction area.

The suggested plan sheet size is 24" x 36" with all sheets in a given set of plans being of the same size. Plan and profile views shall be drawn on double or single plan and profile sheets to minimum scales of one (1) inch equals fifty (50) feet horizontal by one (1) inch equals ten (10) feet vertical, unless otherwise approved by the County Engineer for special cases.

The plans shall consist of:

1. Title Sheet
2. General Layout Sheet
3. Grading Plan (Street and/or storm drainage improvement plans only unless otherwise required by the County Engineer)
4. Erosion Control plans, including all required elevations.
5. Plan and Profile Sheets
6. Testing and Cost Responsibility to Contractor and/or developer (noted)
7. Cross-Section Sheets (Street improvement plans only unless otherwise required by the County Engineer)
8. Standard and Special Detail Sheets

9. Inspection Procedures (noted on Title sheet)

   a. Inspection of subgrade and storm drains for testing and or approval before construction of curbs, storm sewer inlets and the application of base course.

   b. Inspection of completed curbs, storm sewer inlets and base course for testing and or approval before the application of asphaltic or concrete surface.

   c. Inspection of the completed street or roadway, which shall include grass cover of the right of way, to start the two-year maintenance period by the contractor and/or developer.

   d. Final inspection of the streets or roads to determine if the County Highway department specifications and standards for construction for streets and roads have been met and complied with during the (2) two year maintenance period, and is now ready to be recommended by the County Highway Administrator for acceptance into the county road system.

Each sheet should contain a sheet number, including the individual sheet number and the total number of sheets, the engineer's seal, revision block, proper project identification and date.

Each respective type of development project (i.e. sanitary sewer, streets, water mains, etc.) shall be submitted on a separate set of plans unless otherwise allowed by the County Engineer. Plans depicting the location and types of street name and regulatory signs shall be submitted with the street improvement drawings for review. All required signage is to be furnished and installed in connection with the improvement at the contractor and/or developer's expense.

When required by the County Engineer, plans depicting the location of street lights, and all related appurtenances, shall be submitted with the street improvement drawings for review of the appropriate power company. Such review shall be for the purpose of verifying easement locations to be indicated on the final plat. Plans for street light installation shall conform to all applicable standards of the power company having jurisdiction over the work.

Unless otherwise directed by the County Engineer, storm sewer construction details should be incorporated into street construction drawings.

C. TITLE SHEET. The following items shall be included on the title sheet:

1. Name of project
2. County project number
3. Index of sheets included in plans
4. A location map adequately showing project location in relation to major streets (minimum scale of 1" = 2000')
5. General description of project area (by Township, Range, and Section)
6. A summary of plan quantities of principal items, such as:

* Pipe sizes and material, lengths, number of manholes, etc. (sanitary sewers)
* Length of curb and gutter, square yardage or tonnage of asphaltic concrete pavement, etc. (streets)
* Pipe sizes and material, lengths, number of inlets, etc. (storm sewers)
* Pipe sizes and material, lengths, number of valves, etc. (water lines)

Additionally, a separate column shall be provided for listing of "as-built" quantities once the project has been completed and accepted by the County.

7. The project control bench mark shall be identified as to location and elevation within a reasonable distance of the boundary of the project; USGS datum. (Not required on Water Line Plans.)

8. Name, address and telephone number of the consulting engineer and owner/developer.

10. List containing name and telephone number of each utility company and public agency listed below:

    Cable television

    County and State Highway Departments (Local Office)

    Electric Power

    Gas

    Telephone

    Water and Sewer

10. Approval block (see paragraph C of General Plan Requirements)

11. Project engineer's name and seal.

12. Revision schedule.

D. GENERAL LAYOUT SHEET. The following items shall be included on the general layout sheet for all improvement projects.

1. A legend of symbols and abbreviations shall be shown which shall apply to all sheets.
2. North arrow and graphic scale. Scale of the general layout map shall be one (1) inch equals one hundred (100) feet, unless otherwise approved.
3. Layout shall include names of subdivision, block designation, if any, lot designation, or proposed block and lots, all street names, elevation of all lot

corners, and an accurate tie to at least one quarter section corner. An unplatted tract shall have an accurate tie to at least one (1) quarter section corner.

4. Boundary line of project area.

5. A list of general notes to the contractor and/or developer that include at least those notes indicated in the "Procedure For Public Improvement Project Plan Submittal" section of this manual.

In addition, the following items shall be included on the general layout sheet for the particular type of improvement stated below.

Streets

1. Location of all existing and proposed streets and roadways within and adjacent to the project area (list County project).

2. Location of all existing and proposed drainage system improvements (list County project name and number).

Storm Drainage

1. Drainage calculation summary table containing the following information.

   * Pipe size and slope
   * Pipe capacity
   * Velocity (design and at capacity)
   * Time of concentration
   * Runoff coefficient
   * "K" factor (for antecedent precipitation)
   * Design storm (return frequency)
   * Incremental tributary acreage
   * Accumulative acreage
   * Rainfall intensity
   * Rainfall runoff

Sanitary Sewer and Water Lines

1. Location of all existing (water or sewer) lines properly designated within or adjacent to the project area (list County project name and number).
2. Connection point or points to existing facilities (tied to a known point on existing facility) and the type of connection to be utilized.

3. Location of all proposed water or sewer lines and appurtenances with designation and sheet number on which they appear in plan and profile.

E. SITE GRADING PLAN. The following items shall be included on the general layout sheet for all street and/or drainage improvement projects.

1. Property lines and elevation of lot corners identified as to existing or proposed lot and block number.
2. Elevation and location of nearest bench mark (U.S.G.S. datum)
3. One hundred (100) year flood plain line.
4. Existing and final grading contours drawn at intervals not to exceed two (2) feet. Intervals of less than two (2) feet may be required by the County Engineer dependent on the character of the topography.

F. PLAN AND PROFILE SHEETS. The plan and profile shall be shown on a single (split) sheet. The following items shall be included on the plan and profile sheets for all improvement projects.

1. North arrows and graphic scale.
2. Elevation and location of all applicable bench marks (USGS datum).
3. Existing and proposed streets with names and widths.
4. Property lines properly identified as to existing or proposed lot, block and subdivision.
5. All existing and proposed utilities such as power, gas, oil, water, telephone, sewer, cable television, and other items shall be properly located in conformance with the best information available (from the records of the owner of such facilities or field location) and identified as to size, depth, material, and type of construction.
6. All existing and known proposed improvements within seventy-five (75) feet each side of center line shall be shown at their proper locations. This shall include such existing items as paved streets, curbs and gutters, driveways, culverts, fire hydrants, utility poles, trees, shrubs, fences, walls, houses, and other such items, and shall be identified as to type, size, material, etc., as may be applicable.
7. All existing easement and right-of-way information recorded with the county.
8. All proposed easement and right-of-way information.
9. Minor construction notes shall appear on the proper plan and profile sheets.
10. Locations and widths of existing and proposed sidewalks.

In addition, the following items shall be included on the plan and profile sheets for the particular type of improvement stated below.

Streets

1. Station and critical elevation (flowline, invert of pipe, etc.) of all utility or drainage appurtenances, existing and proposed.
2. Flow direction arrows, particularly at intersections.
3. Match lines and consecutive sheet number, beginning with cover sheet.
4. Station and elevation of all curb returns (at 1/5 points); horizontal P.C.'s, P.T.'s, etc.; high or low point of all vertical curves; existing and proposed.
5. Curb return radii, existing and proposed.
6. Complete horizontal curve data. (R, L, Tan)
7. Centerline stations of all non-single family residential driveways and all intersecting roadways.
8. Basis of plan view and profile elevations shall be the same, i.e., flowline and flowline, top of curb and top of curb, etc.
9. Existing grade above centerline shown as a dashed line; proposed finish grades or established street grades shown as a solid line.
10. All design elevations shall be centerline, top of curb, lip of gutter, or flowline (preferred) for six (6) inch vertical curb and gutter; or lip of gutter, or flowline (preferred) for combination curb, gutter and walk. The basis for as-built information shall be the same as the design (both flowline or both top of curb, etc.). All design elevations shall be based on adjacent abutting streets and shall show existing profile a minimum of one hundred fifty (150) feet beyond the boundary of the project.
11. Stationing continuous for the entire portion of the roadway shown in the plan view (one hundred (100) feet minimum stationing), with the centerline station of all non-single family residential driveways and all intersecting roadways clearly labeled.
12. All existing curbs, gutters, sidewalks, and pavement adjacent to the proposed design (minimum distance of one hundred (100) feet). Basis for existing grades shall be "as-built" or field verified elevations at intervals not to exceed fifty (50) feet. Previously approved designs are not an acceptable means of establishing existing grades.
13. Station and elevation of all P.C.R.'s, horizontal P.C.'s, P.C.C.'s, etc.; existing and proposed.
14. Station and elevation of all vertical grade breaks, existing (as-built) and proposed. (The use of grade breaks with proposed construction is discouraged.)
15. Distance and grade or slope between grade breaks.
16. Vertical curves, where necessary, with VPI, VPC, and VPT, high or low

point (if applicable) stations and elevations. All vertical curves shall be labeled with length of curve (L) and K (=L/A). All vertical curves shall be symmetrical.

17. Design speeds and stopping sight distances for all vertical and horizontal curves.

18. Existing and proposed utilities. Field verified elevations and locations are required to be indicated on the plans for all utilities (existing or proposed) which will potentially affect the design and construction of the improvement.

19. The location and designation of all signs (regulatory and street name) to be installed in connection with the project.

Storm Drainage

1. Detailed alignment of the storm sewer along with all appurtenances, sizes of lines, conduit material and wall thickness, and other details relating to the storm drainage system including inlet and junction box (manhole) stations and top and invert elevations.

2. All existing drainage facilities and structures such as, but not limited to, irrigation ditches, roadside ditches, improved or unimproved drainage channels, gutter flow directions, culverts, etc. All pertinent information such as size, shape, slope, location, etc. of such facilities shall be included to facilitate review and approval of the plans.

3. Roadway section and grade including type of curb and gutter and gutter flow directions.

4. Erosion control and energy dissipation devices.

5. Proposed outfall point for runoff from the project area along with required easement information.

6. Routing and cumulative flows at various critical points along the drainage system for both the standard design storm and major storm runoff.

7. Critical minimum finished floor elevations of all buildings adjacent to the project for protection from major storm runoff.

8. Distances between storm sewer system components and other existing or proposed utilities within the right-of-way or drainage easement.

Sanitary Sewers/Water Lines

1. Existing water distribution facilities including, but not limited to, pipe size and location, valves, fire hydrants, blowoffs, etc.

2. Existing sanitary sewer facilities including, but not limited to size, slope, location, hydraulic capacity, and all pertinent information regarding which trunk line will ultimately receive the wastewater collected by the proposed system.

3. Proposed piping with all appurtenances plainly labeled.

4. Existing or proposed easements and/or tracts through offsite areas.

5. Estimated average quantity of wastewater generated offsite that would be tributary to the proposed development, naturally as developed. The "Land Use Plan", which is a part of the Comprehensive Plan for Clay County, shall be the basis for determining the future use of offsite undeveloped land.

6. Proposed minimum, maximum, and average design flows at all junction manholes. (Manholes where two (2) or more branches have peak flows in excess of three (3) c.f.s.)

7. All design elevations shall be invert of pipe.

8. Stationing continuous for the entire length of the utility beginning at the downstream end of the project. Center line of roadway shall be the basis for stationing whenever possible.

9. Existing utilities, particularly where crossed, with "as-built" elevations and stations.

10. Detailed alignment of the proposed sewer with the manhole designation, either by station and angle shown at each manhole or dimensioned ties to property lines at reasonably frequent control points to provide unquestionable locations of the sewer within street right-of-way or on private property.

11. The channel center line of waterways within fifty (50) feet either side of center line of sewer shall be shown.

12. All manholes shall be shown with manhole designation station and invert elevations. Drop manholes shall be designated as such. Invert elevations shown shall be the invert of the pipe in and out of the manhole. Proposed finish grade elevation of top of manhole shall be shown. Distance between manholes shall be shown, indicating whether measured to end of pipe or center of manhole as well as the gradient, pipe size, and type of material.

13. Results of all rock borings shall be shown at the proper locations.

14. Accurate elevations of either the lowest floor surface shall be shown, and identified, for all existing and/or proposed structures for all building sites to be served by the proposed sewer system.

15. A uniform system of line and manhole designation shall be used subject to the approval of the County Engineer's office.

16. Station, length, and size of each stubline.

17. Profile view shall show existing grade above center line as a dashed line, proposed finish grades or established street grades by solid lines, and shall show the flow line of any drainage channel, either improved or unimproved, within fifty (50) feet either side of center line. Each line shall be properly identified. The proposed sewer shall be shown as double solid lines properly showing the height of the pipe.

18. Alignment of the proposed water line dimensioned from curb lines or right-of-way lines.

19. Designation by station of all fire hydrants and line valves.

G. CROSS-SECTION SHEETS. The following items shall be included on the cross-section sheets.

1. Typical roadway cross-section for all roadways, existing or proposed, within and adjacent to the proposed development. These cross sections shall appear on the detail sheet. They shall indicate type of roadway(s), profile grade design point (centerline, flowline, top curb, lip of gutter, etc.), roadway width, right-of-way, type of curb, gutter, and walk, pavement cross slope, etc. Cross-sections to show existing grade lines a minimum of ten (10) feet beyond right-of-way lines.

2. Cross-sections shall be shown at all intersecting streets and driveways.

3. Channel cross-sections shall be shown for all drainage channel improvements.

4. Additional cross-sections shall be shown as required by the County Engineer in order to clearly describe the extent of the grading operations.

H. STANDARD AND SPECIAL DETAIL SHEETS. Detail sheets shall be included to show all details of appurtenances, materials, and construction whether or not covered by the Clay County Standards. Details shall conform to the Clay County Highway Department/PWD Standards and are to be drawn clearly and neatly with proper identifications, dimensions, materials, and other information necessary to insure the desired construction.

I. STATE STANDARDS TO SUPPLEMENT COUNTY STANDARDS. Any specifications as to procedure, equipment or materials, not covered in the street specifications and standards, amendments thereto, or the County Highway Departments special instructions, shall be subject to the state standards for Highway Construction, 1996 Edition.

J. CONSTRUCTION RECORD DRAWINGS. Construction record (as-built) drawings shall be submitted to the County Engineer upon completion of the project and prior to final acceptance of the project by the Clay County Highway Department/PWD and Clay County Commission. The design engineer shall provide the County with one (1) set of prints for all

public improvement projects corrected to show the project as constructed and shall accurately and completely denote all changes made during the course of the work. Each sheet within the plans shall be clearly marked as "Conforming to Construction Records" and shall include the date of revision and certifications by the engineer. In addition, Clay County will be provided all of the above on completion on computer disc or CD for incorporation into the County's Public Works information system.

A. DESIGN FACTORS. Sanitary sewers should be designed for the ultimate tributary population. Due consideration should be given to current zoning regulations and approved planning and zoning reports where applicable. Sewer capacities should be adequate to handle the anticipated maximum hourly quantities of sewerage and industrial waste together with reasonable consideration given to infiltration/inflow.

B. SEWER DESIGN. Sewers shall be designed for the total tributary area using the following minimum criteria:

Interceptors and trunk lines	0.01 CFS/Acre
Laterals and sub-mains	0.02 CFS/Acre

Using this criteria all pipes are to be sized flowing full.

C. MAXIMUM SIZE. The diameter of sewers proposed shall not exceed the diameter of the existing or proposed outlet, whichever is applicable, unless otherwise approved by the County Engineer.

D. MINIMUM SIZE. No public sewer shall be less than eight (8) inches in diameter. Stublines for service connections shall not be less than four (4) inches in diameter and shall be extended at a ninety (90) degree angle to the main sewer line.

E. MATERIALS OF CONSTRUCTION. Sanitary sewers shall be constructed of pipe material resistant to or protected from bacterial degradation, acid and alkaline solutions, normal sewer temperature variation, abrasion, and industrial wastes or other materials which may be transmitted by the collection system.

The following types of commercial pipe are approved for gravity sanitary sewer systems constructed in the unincorporated areas of Clay County:

Vitrified Clay Pipe	ASTM C700 extra strength
Reinforced Concrete Pipe	ASTM C76, Class II (Wall B or C)
Ductile Iron Pipe	ANSI A21.51; ASTM A536, Grade60-42-10; thickness Class 50, unless otherwise required by the County Engineer.
PVC Pipe	ASTM D3034, Type PSM Polyvinyl (Chloride), SDR 35; PVC Material shall conform to ASTM D1784 and shall have a cell classification of 12454-B, 12454-C, or 13364-B. The minimum pipe stiffness for pipe used for stublines shall be SDR 26.

The use of thermoplastic pipe shall be limited to residential or commercial areas as approved by the County Engineer and shall not be used for pipelines exceeding fifteen (15) inches in diameter unless otherwise approved.

F. MINIMUM SLOPE. All sewers shall be designed to give mean velocities when flowing full of not less than 2.0 feet per second.

All velocity and flow calculations shall be based on the Manning Formula using an "n" value of 0.013. The following slopes shall be the minimum for the size indicated.

SEWER SIZE	MINIMUM SLOPE IN PERCENT FULL AND HALF FULL FLOW
8"	0.40
10"	0.28
12"	0.22
15"	0.15
18"	0.12
21"	0.10
24"	0.08

Exceptions to these minimum slopes shall be made at the upper end of the lateral sewers serving under thirty houses. Said sewers shall have a minimum slope of 0.76 percent.

Where lateral sewers serve less than ten (10) houses, the minimum slope shall not be less than 1 percent unless otherwise approved by the County Engineer.

G. INCREASING PIPE SIZE. When a sewer joins a larger one, the invert of the larger sewer should be lowered sufficiently to maintain a continuous energy gradient.

H. HIGH VELOCITY PROTECTION. In situations where flow is continuous and grit is a problem, and where velocities greater than ten (10) feet per second are possible, special provisions shall be made to protect against abrasion damage to the pipe. Such protection may be attained utilizing ductile iron pipe.

I. ALIGNMENT. All sewers shall be laid with straight alignment between manholes.

J. MANHOLE CONSTRUCTION. Manholes shall be installed at the end of each line; at all changes in grade, size, or alignment; at all intersections; and at a distance not greater than four hundred (400) feet for sewers fifteen (15) inches or less in diameter and not greater than five hundred (500) feet for larger sewers.

K. MANHOLES. The construction of all manholes shall conform to the details shown on the

Standard Drawings.

The minimum horizontal clear distance within the barrel of standard manholes shall not be less than four (4) feet. Manholes with connecting pipe diameters greater than twenty-four (24) inches shall have a minimum inside clear dimension of five (5) feet.

Drop manholes should be avoided as much as possible. However, an outside inside pipe shall be provided for a sewer entering a manhole at an elevation of twenty-four (24) inches or more above the manhole invert. The outside drop pipe shall be protected against breaking or settling by the use of concrete encasement. The drop pipe shall have the same nominal diameter as that of the incoming sewer.

Without utilizing drop manholes, the difference in elevation between the invert of any incoming sewer and the invert of the outgoing sewer should not exceed twenty-four (24) inches except where required to match crowns. When a sewer joins a larger one, the crown of the smaller sewer shall not be lower than the crown of the larger one. The minimum drop through manholes shall be 0.2 feet.

Where manholes are to be built in close proximity to streets, the top of manhole elevation shall be set within the following limits:

Minimum Elevation	1/4" per foot rise above top back of curb
Maximum Elevation	½" per foot rise above top back of curb

All other sanitary sewer lines (sewer lines across unplatted land, etc.) shall have the tops of manholes set flush with the existing ground elevation. The top of all manholes shall be located above the one hundred (100) year flood plain.

Any variation from the above top of manhole criteria will require a letter of explanation to be submitted with the drawings and be subject to approval by the County Engineer.

L. SEWER LOCATIONS. Sanitary sewers shall be located within street or alley rights-of-way (outside pavement limits) unless topography dictates otherwise. When located in easements on private property, access shall be provided to all manholes. A manhole shall be provided at each street or alley crossing.

End lines shall be extended to provide access from street or alley rights-of-way where possible. Imposed loading shall be considered in all locations. Not less than eight (8) feet of cover shall be provided over top of pipe in street and alley rights-of-way and five (5) feet in all other areas unless otherwise approved by the County Engineer.

M. CLEANOUTS AND LAMPHOLES. Cleanouts and lampholes will not be permitted.

N. PROTECTION OF WATER SUPPLIES. There shall be no physical connection between a public or private potable water supply system and a sewer, or appurtenance thereto, which would permit the passage of any wastewater or polluted water into the potable water supply.

1. Horizontal Separation: Sewer mains shall be laid at least ten (10) feet horizontally from any existing or proposed water main. The distances shall be measured edge to edge. In cases where it is not practical to maintain a ten (10) foot separation, the Engineer may allow deviation on a case-by-case sewer closer to a water main, provided that the water main is in a separate trench or on an undisturbed earth shelf located on one side of the sewer at such an elevation that the bottom of the water main is at least eighteen (18) inches above the top of the sewer.

2. Crossings: Sewers crossing water mains shall be laid to provide a minimum vertical distance of eighteen (18) inches between the outside of the water main and the outside of the sewer. This shall be the case where the water main is either above or below the sewer. The crossing shall be arranged so that the sewer joints will be equidistant and as far as possible from the water main joints. Where a water main crosses under a sewer, adequate structural support shall be provided for the sewer to prevent damage to the water main.

3. Special Conditions: When it is impossible to obtain proper horizontal and vertical separation as stipulated above, the sewer shall be designed and constructed equal to water pipe, and shall be pressure tested to assure water tightness prior to backfilling.

No water pipe shall pass through, or come in contact with, any part of a sewer or a sewer manhole.

O. AERIAL CROSSINGS. Adequate support shall be provided at all joints in pipes utilized for aerial crossings. Only ductile-iron pipe with restrained joints shall be used unless otherwise approved by the County Engineer.

A. GENERAL. Proposed extensions of the water distribution system shall, in general, follow the pattern established in the Water Facilities Plan as adopted by the Clay County Highway Department/PWD. Deviations from this general policy may be deemed necessary by the County Engineer should the provision of adequate service to prospective customers or fire protection needs, existing or anticipated, in the area to be served warrant said deviations.

No public water line shall be constructed less than six (6) inches in diameter.

B. LOCATION OF WATER MAINS AND APPURTENANCES. Proposed water mains shall be so located within street right-of-way to provide the least interference with the location of other utility lines. Street grades and elevations of proposed main shall be taken into consideration so that once constructed they will not require re-grading or relocation.

C. DEPTH. All water mains shall have a minimum cover of forty-two (42) inches.

D. MATERIALS OF CONSTRUCTION. Ductile iron pipes shall be used for all mains constructed in the Clay County Highway Department/PWD.

The ductile iron shall conform to ANSI A21.51; ASTM A536, Grade 60-42-10; AWWA C151. The minimum nominal thickness class for ductile iron pipe shall be 50, unless otherwise designated by the County Engineer.

Joints, unless otherwise specified, shall be of the push-on type conforming to ANSI A21.11/AWWA C111, except gaskets shall be synthetic rubber. Natural rubber will not be acceptable. The pipe shall be cement mortar lined, conforming to ANSI A21.4/AWWA C104 and shall be coated inside and out with a bituminous coating.

Ductile-iron fittings shall be complete with all accessories and shall be ASTM A536, Grade 70-50-05, conforming to ANSI A21.10/AWWA C110, ANSI A21.53/AWWA C153, 350 PSI pressure rating. Joints shall be of the standard mechanical joint type conforming to ANSI A21.10/AWWA C104, and shall be coated inside and out with a bituminous coating.

E. FIRE HYDRANTS. Fire hydrants shall conform to AWWA C502 and shall be traffic models with breakaway flanges and shall have one (1) 4 ½ inch pumper nozzle and two (2) 2 ½-inch nozzles. All hydrants shall be furnished with auxiliary gate valves.

Hydrants should be placed at or near street intersections and at intermediate points when block lengths become long. Under no circumstances shall the spacing of fire hydrants exceed five hundred (500) feet in residential areas or three hundred (300) feet in commercial areas.

Fire Hydrant installations shall conform to the Standard Drawings.

F. LINE VALVES. Gate valves shall be of the resilient-seated configuration and shall

conform to the applicable requirements of AWWA C509.Gate valves shall be used in all water mains less than twelve (12) inches in diameter and smaller.

Butterfly valves shall conform to AWWA C504. Butterfly valves shall be used in mains twelve (12) inches and larger than twelve (12) inches in diameter or where otherwise approved by the County Engineer.

Valves shall be placed in all straight runs of pipe at intervals not to exceed eight hundred (800) feet. Where two lines intersect, a valve should be placed in each pipe on each side of the intersection. Valves should be so placed that any pipe two (2) blocks long can be cut out of the general circulation without interrupting service in the rest of the system.

Extension stems shall be provided for buried valves when the operating nut is more than three feet below finished grade. Each extension stem for a buried valve shall extend to within three (3) feet of the ground surface, shall be provided with spacers which will center the stem in the valve box, and shall be equipped with a wrench nut.

H. TAPPING SLEEVES AND VALVES. Tapping sleeves and valves shall be used where required to connect to existing in-service mains.

The valves shall be Stainless Steel as set forth in the Technical Specifications of the Clay County Highway Department/PWD.

Tapping sleeves shall be of the flanged-outlet type designed for attachment to the flanged inlet end of the tapping valve, and shall be provided with mechanical joint ends at each end of the run.

I. CONNECTIONS TO EXISTING WATER MAINS. Connections to existing water mains shall be made in such a manner as to provide the least amount of interruption to water service. In the event closing of valves to make a connection will affect a customer who cannot be without service, provisions shall be made on the plans for a temporary service.

J. PROVISIONS FOR FUTURE EXTENSIONS OF WATER MAINS. At the termination of all water mains or at locations as specified by the County Engineer, a dead end assembly in accordance with the Standard Drawings of the Technical Specifications of the Clay County Highway Department/PWD shall be provided to allow for future water main extensions.

Flushing assemblies shall be used only at locations approved by the County Engineer to provide for thorough flushing of all water mains in the project area. Whenever practical, water mains five hundred (500) feet and longer shall be provided with a fire hydrant for flushing.

K. THRUST BLOCKING. Reaction blocking of adequate size shall be provided at all tees, elbows and bends to resist all resultant thrusts due to hydrostatic pressure. All blocking shall conform to the Standard Drawings. Restrictive joints may be used as set forth in the Technical Specifications of the Clay County Highway Department/PWD.

L. HIGHWAY AND RAILROAD CROSSINGS. All crossings of highways or railroads shall be made by boring or tunneling. The work shall be in conformity with all requirements and

regulations and be under the control of the authority owning or having jurisdiction over and control of the right-of-way in each case.

M. STREET CROSSINGS. Open cutting of streets shall be allowed only where permitted by the County Engineer. At locations where open cutting is not permitted, the crossing shall be made by boring or tunneling. Crossings made by boring or tunneling shall require a casing pipe unless otherwise approved by the County Engineer. All work and materials shall be in conformity with all requirements of the Technical Specifications of the Clay County Highway Department/PWD. The diameter and length of the casing pipe to be used shall be as determined by the County Engineer.

N. FIRE FLOW REQUIREMENTS. Public improvement plans for water line projects serving development sites other than single family or duplex subdivisions shall be reviewed for fire protection sufficiency. The Chief Building Official shall determine the amount of water that is required for fire protection based on I.S.O. guidelines for the proposed type of structures to be built within the development. The design engineer shall obtain the flow requirement and then determine if the existing and proposed water lines can provide this flow based on existing operating conditions. Calculations verifying that the required flows can be met shall accompany the drawings when submitted for approval.

DESIGN CRITERIA FOR
STREET IMPROVEMENTS

A. GENERAL. Proposed street improvements within the County shall conform to the pattern established in the Major Street Plan as adopted by Clay County.

Street improvements shall be designed to conform to applicable codes, regulations, ordinances, and the provisions set forth in these criteria as established by the Clay County Highway Department/PWD. Plans for said improvements shall be submitted to the County Engineer for approval and shall include all information as may be required or described hereinafter.

B. FUNCTIONAL CLASSIFICATION OF STREETS. The classification of streets shall be generally defined as follows:

1. Local Streets. A street designed to provide access to abutting property from collector and arterial streets.

2. Collector/Commercial Streets. Streets, which, in addition to serving abutting properties, intercept local streets, connect with community facilities and carry neighborhood traffic to the arterial street systems. Commercial streets serve areas predominately zoned for commercial or industrial uses.

3. Arterial Streets. A street or road of considerable continuity which serves or is intended to serve as a principal trafficway between separated areas or districts and which is the main means of access to the collector street system, highways or expressways.

Typical cross-sections of these classifications are shown on Design Aids No. 1 and No. 2.

C. STREET DESIGN STANDARDS.

	Major Arterial	Minor Arterial	*Major Collector	Local Rural/Low	Local Urban (Res)	Local Comm/Ind
Minimum Right-of-Way Width (Ft)	120	100	60	60	50	70
Pavement Width	44+	32+	32+	24	24	32
Degree of Curvature	12.5	12.5	23	28	28	23
Curb Radii	30	30	25	25	25	30
Number of Lanes	2-4	2-4	2-3	2-3	2	2-3
Pavement Section	(2)	(2)	(3)	(3)	(4)	(3)

	Major Arterial	Minor Arterial	*Major Collector	Local Rural/Low	Local Urban (Res)	Local Comm/Ind
Minimum Pavement Depth (Asphalatic Concrete) inches	12	12	10	8	8	10
Design Volume (VPD) Range	24,000 to 36,000	12,000 to 24,000	1,500 to 12,000	1,500 and under	1,500 and under	1,500 and under
**Design Speed (MPH)	50	35	30-35	25-30	25	25-35
Maximum Grade	6%	6%	6%	6%	8%	6%
Minimum Grade	.5%	.5%	.5%	.5%	.5%	.5%
Curb Return Radius	50'	50'	30'	25'	25'	25'
Minimum Radii Horizontal Curve	510'	510'	380'	200'	200'	200'
Minimum K Crest Vertical Curve	110-150	60-80	40-50	30	30	30
Minimum K Sag Vertical Curve	90-110	60-70	50	30	30	30
Minimum Private Curb Cut Spacing (feet)	350	1 per property	1 per property	1 per property	1 per property	1 per property
Minimum Distance from Intersection R.O.W. to curb cut (feet)	250	200	150	25	25	25
***Sidewalk Width (feet)	5	5	4	4	4	5
Parking Permitted	No	No	No	No	No	NO
Storm Sewers	Yes	Yes	Yes	Yes	Yes	Yes
Curb & Gutter	CG-1	CG-1	CG-1 OR CG-2	CG-2	CG-2	CG-1

* Also applicable to commercial streets.

** Design Speed criteria for horizontal and vertical alignment should meet the requirements of the current edition of "A Policy on Geometric design of Highways and Streets, AASHTO".

*** Both sides of roadway.

D. OFF-CENTER STREET INTERSECTIONS. Off-center street intersections shall be separated by a minimum centerline to centerline distance of one hundred and fifty (150) feet.

E. INTERSECTION VERTICAL ALIGNMENT. In all cases where a higher functional street

intersects with a lower functional street, normal street crown shall be maintained on the higher functional street. Where streets of equal function intersect, street grades shall coincide in the center of the intersection with reduced rideability for both streets, or a warping of the cross slope for both streets. (Design Aid No. 5)

F. MINIMUM ANGLE OF INTERSECTION. It is desirable for all intersections to meet at approximately a ninety (90) degree angle. Skewed intersections should be avoided, and in no case should the angle be less than sixty (60) degrees.

G. MAXIMUM GRADIENT. The maximum gradient for streets as noted in Section C may be exceeded only upon written approval of the County Engineer. Such approval will only be granted in unusual cases where grades within the acceptable limits cannot be obtained.

H. GRADING GRADIENTS. The finished grade within the limits of the right-of-way shall slope from one-quarter (1/4) inch vertical to one (1) foot horizontal minimum, to one-half (½) inch vertical to one (1) foot horizontal maximum measured above the back of the curb. The grading gradients may be varied only upon written approval of the County Engineer.

I. TANGENT LENGTH. The minimum tangent length between reverse curves shall be fifty (50) feet for local streets and one hundred (100) feet for collector/commercial and arterial streets, except that no tangent will be required for radii longer than five hundred (500) feet.

J. CONNECTIONS TO EXISTING PAVEMENTS. Where a new street is to connect to an existing street, all deteriorated or cracked asphalt within five (5) feet of the connection point shall be removed to a point where sound material is found. If full-depth pavement removal is required the subgrade will be recompacted to 95 percent of standard density.

K. STORM DRAINAGE. All storm drainage works constructed in connection with street improvements shall be designed in accordance with the Clay County Highway Department/PWD Design Criteria for Storm Sewers and Appurtenances.

L. CUL-DE-SACS. At locations where streets are to be terminated and a vehicular connection between adjacent streets is not required a cul-de-sac may be permitted. Such cul-de-sac shall be constructed with a minimum radius of fifty (50) feet and 100'in diameter to the back of the curb.

M. TEMPORARY TURN-AROUNDS. At locations where streets are to be temporarily terminated which will be extended at a later date, and said street extends beyond the intersection of an adjacent street more than one (1) lot, a temporary cul-de-sac shall be constructed with a minimum radius of fifty (50) feet. The temporary cul-de-sac shall be constructed of asphaltic concrete with a minimum depth of six (6) inches. Curb and gutter will not be required. The cul-de-sac shall be constructed within the limits of a permanent construction easement.

N. MONUMENT BOXES. Monument boxes conforming to the Standard Drawings shall be installed at all quarter section corners and any other monuments involved in the street construction.

O. OTHER DESIGN CRITERIA. All other street design elements not contained within this criteria shall be in accordance with the most current edition of "A Policy on Geometric Design of Highways and Streets" authored by the American Association of State Highway and Transportation Officials (AASHTO) or other applicable AASHTO design guides.

P. DRIVEWAY ELEVATIONS. Driveways shall attain top of curb elevation within the right-of-way. Driveway grades within right-of-way shall be 8 percent maximum until curb height is reached. Break over grades for crest drives shall be 8 percent maximum and sag drives shall be 12 percent maximum. Driveway elevation shall not be more than six (6) inches above or below the normal shoulder elevation at the right-of-way line, to allow for a smooth sidewalk profile.

Q. SIGNAGE. Street name and regulatory traffic signs conforming to the Standard Drawings shall be furnished and installed at the appropriate locations in connection with the street improvement. All regulatory signage shall be in conformance with MUTCD requirements and shall be approved by the County Engineer.

A. New or replacement box culverts and/or bridges in Clay County shall be to the Missouri Highway and Transportation Department Standards for Highway Construction Edition, 1999. Minimum width each lane twelve (12) feet; minimum weight design HS-20.

A. GENERAL. This section sets forth the minimum technical criteria for the analysis and design of drainage systems. All development plans submitted for approval to the Clay County Highway Department/PWD must be accompanied by an adequate storm drainage system analysis and design in accordance with the criteria as hereinafter described and shall be performed by a licensed professional engineer in the State of Missouri.

The criteria set forth in this section shall apply primarily to that element of the drainage system outside the limits of the one hundred (100) year regulatory floodplain unless otherwise noted. Improvements within the limits of the one hundred (100) year floodplain shall conform to requirements set forth in applicable County codes and ordinances and the regulations of any other agency having jurisdiction over such area.

1. Exceptions. In subdivisions in which all of the lots are at least 10 acres in area, the following exceptions apply:

   a. The provisions of Section 5601.A.1 of the APWA standards shall be modified so that the channelized stormwater flows are only required to be piped if the flow from a ten (10) year storm event can be conducted under gravity flow conditions by a forty-eight (48) inch or narrower diameter reinforced concrete pipe at a one (1) percent grade.

   b. The provisions of Section 5601.1.B of the APWA standards shall be modified so that drainage easements are not automatically required for open stormwater conveyances. However, those areas which would be required to be located within easements according to the APWA standards, shall be designated as "no-build" zones on the proposed development plan or plat.

   c. The provisions of Section 5606 of the APWA standards shall be modified to eliminate the requirement for dedication of stormwater detention and retention facilities. At the time of development approval the applicant shall obtain the County Engineer's approval of a plan for future maintenance of any such facilities required for the proposed development.

   d. Drainage studies shall not be required unless expressly required by the County Commission or Planning and Zoning Commission based on drainage conditions in the immediate area of the subject development.

B. MINIMUM STANDARDS OF ANALYSIS. Unless otherwise approved by the County Engineer, the following criteria will be utilized to determine the adequacy of any storm drainage facility design submitted for approval.

1. Methodology of Analysis. In determining the amount of storm water runoff resulting from a development and the amount of flow at various points throughout the drainage system, it is important for the designer to relate the methodology to be utilized in his calculations to the proportionate size of the tributary watershed areas.

In developments where the area contributing runoff is one hundred (100) acres or less, the Rational Method of calculating the quantity of runoff shall be utilized. Developments where the area contributing runoff exceeds one hundred (100) acres shall be designed using the unit hydrograph method (SCS) or other methodologies approved by the County Engineer.

2. Criteria for Drainage System. All calculations relating to runoff analysis shall be based upon the proposed land use and shall take into consideration any contributing runoff from areas adjacent to the development site. Storm water runoff analysis from adjacent existing developed areas shall be based upon current land usage and topographical features. Property adjacent to the study area which is undeveloped shall be considered as fully developed in accordance with the most probable anticipated future land use. Such land use shall be determined from the County Comprehensive Plan and the County zoning map. In the event that the future land use of a specific undeveloped property cannot be adequately projected from available information, the average runoff coefficient © to be used shall not be less than 0.65 for use in the Rational Method or an appropriate equivalent value as approved by the County Engineer for any other method. The most likely flow pattern to be utilized for an undeveloped area shall be based upon existing natural topographical features.

Average land slopes in both developed and undeveloped areas may be utilized to calculate runoff rates. The exception to this shall be in areas with existing well-defined drainage patterns and slopes; in which case the actual slope shall be used. Existing runoff flow rates and velocities at locations of discharge from adjacent upstream developments shall be utilized in drainage system design. Drainage facilities shall be designed to minimize the velocity of overland flow so as not to cause erosion damage. In areas where excessive velocities exist, adequate dissipating structures shall be provided as required to result in velocities appropriate for the type of erosion control to be utilized or as specified in this criteria.

The primary function of roadways within a development shall be reserved for the conveyance of traffic. The use of these facilities as a storm runoff facility shall be restricted to the requirements established and set forth in these design criteria.

The utilization of onsite or on stream detention and natural drainage ways is recommended and encouraged where feasible. Relocation of existing natural drainage ways will not be approved unless such relocation has been substantiated as a result of a thorough and complete analysis of the resultant consequences.

The designer shall consider all problem areas of his design and analysis to prevent the transfer of these problems from one location to another. All points of drainage outfall shall be designed to preclude creation of downstream flooding problems and hazards to the public. Approval will not be given to any project which involves the construction of any structure or the placement of fill material which will hinder or impair surface or subsurface drainage from surrounding areas.

C. MINIMUM STANDARDS OF DESIGN. Storm water runoff shall be carried by enclosed

systems or open channels on the basis of criteria established in this section and subject to the final determination and approval of the County Engineer.

1. Enclosed Systems: Enclosed systems consisting of underground pipes, culverts, and similar functional underground structures shall be used to convey storm water at all locations:

   a. Where the design peak discharge of a ten (10) year return period storm is equal to or less than the capacity of a seventy-two (72) inch diameter round pipe having a Manning's "n" of .013.

   b. Within the right-of-way of improved streets, regardless of system design capacity.

   c. Within sixty (60) feet of any existing or proposed habitable building, regardless of system design capacity.

   d. Where the design peak discharge of a ten (10) year return period storm equals or exceeds 8 c.f.s. and the collected drainage is generated from more than one (1) lot.

   Enclosed systems may be used to convey storm water at all locations where open systems are permitted.

2. Open Systems: Open systems consisting of natural and/or improved open channels with intermittent culverts or bridges crossing streets and other surfaced areas may be used to convey storm water at all locations where the use of an enclosed system is not required by the foregoing criteria.

3. Overflow Systems: Each conveyance element of the storm water drainage system (whether enclosed or open) shall include an overflow system having sufficient hydraulic capacity when combined with the capacity of the conveyance elements to convey the peak discharge generated by a one hundred (100) year return period storm without damage to land or buildings, defined as follows:

   > One hundred (100) year stage; plus one (1) foot freeboard, at an elevation equal to or greater than the lowest elevation at which water may enter any proposed or existing building or structure.

   Complete side and rear drainage systems meeting the criteria established previously shall be provided along the boundaries of new subdivisions or developments by the Developer or property owner.

4. Design Storm Frequencies. Enclosed and open channel conveyance system components shall be designed for the following return period storms, irrespective of the land use in which the system is located or the land use in the drainage area tributary to the system:
   a. In-System Capacity:

Floodway in 100 year Flood Plain	100 year
Bridges, Pipes, and Culverts (any crossing of and/or under roads)	100 year
All Other System Components	50 year

b. Overflow Channels: The combined capacity of the overflow channel and in system conveyance element shall be sufficient to convey the one hundred (100) year storm at all locations.

5. Runoff Computation. The rational method of calculating storm water quantities, Q = KCiA, shall be used with the following definitions of terms and arbitrary values:

a. Q is the quantity of runoff in cubic feet per second and is the basis for design of the storm drainage system.

b. K is a dimension less coefficient to account for antecedent precipitation.

c. C is the weighted coefficient of runoff from the tributary area and shall have the following values where applicable:

LAND USE/ZONING	AVERAGE PERCENT IMPERVIOUS	AVERAGE PERCENT PERVIOUS	RATIONAL METHOD "C"	S.C.S. CURVE NUMBER
Business				
Downtown Area	95	5	0.87	96
Neighborhood Areas	85	15	.81	94
Residential				
Single-Family Areas	35	65	0.51	83
Multi-family Areas	60	40	0.66	88
Churches and Schools	75	25	0.75	92
Industrial				
Light Areas	60	40	0.66	88
Heavy Areas	80	20	0.78	93
Parks, Cemeteries	10	90	0.36	77
Railroad Yard Areas	25	75	0.45	80
Undeveloped Areas				
Permanent unimproved Areas, Greenbelts, etc.	0	100	0.3	75
All Surfaces				
Impervious: Asphalt, concrete, roofs, etc.	100	0	0.9	98
Turfed	0	100	0.3	75
Wet detention basins	100	0	0.9	98

Land areas not zoned, but whose future land use is defined by an adopted land use plan, shall be assigned runoff coefficients for the land use indicated

by such plan. Undeveloped areas designated as agricultural or those for which no specific future land use is indicated shall be assigned a minimum of thirty-five (35) percent impervious surface for purposes of the design of storm drainage systems. (C=.51, CN=83).

As an alternative to the above coefficients; and for areas not listed above (planned building groups, shopping centers, trailer parks, etc.) a composite runoff coefficient based on the actual percentages of pervious and impervious surfaces shall be used.

d. I is intensity of rainfall in inches per hour and shall be determined for the yearly frequency stipulated previously and as derived from the intensity duration curves included as a part of this criteria.

Time of concentration (TC) equals the overload flow time to the most upstream inlet or other point of entry to the system plus the time of flow in the system upstream from the point under consideration. (TC = Ti + Tt)

(1). Inlet time (Ti) shall be calculated utilizing the following formula or determined graphically from Design Aid No. 10, but shall not be less than 5.0 minutes or greater than 15.0 minutes:

$$Ti = \frac{1.8\,(1.1 - C)\,D\,\frac{1}{2}}{S\,1/3} \text{ minutes}$$

C is the Rational Method runoff coefficient.

D is the overland flow distance parallel to slope.

S is the slope of the tributary area surface perpendicular to contour in percent.

(2). Travel time (Tt) shall be calculated as the length of travel in the channelized system divided by the velocity of flow. Velocity shall be calculated by Manning's equation assuming all system elements are flowing full without surcharge. Travel time may be determined graphically from Design Aid No. 11, in lieu of calculation.

When the upstream channel is unimproved, it shall be assumed that future construction of drainage system improvements will increase the velocity of flow.

Velocity used for calculating Tt shall be:

Average Channel Slope (Percent)	Velocity (fps)

<2	7
2 to 5	10
>5	15

e. A is the area in acres contributing to the drainage system. All upstream tributary areas are to be considered as fully developed as zoned or planned at the time of design.

6. Antecedent Precipitation. "K" represents the frequency factor used to account for antecedent precipitation and shall have the following values:

Storm Return Period (Years)	K*
10	1.0
25	1.1
50	1.2
100	1.25

*The product of K x C shall not exceed 1.0.

7. Pipe Sizing. Pipe sizes in integrated underground systems shall be determined in accordance with the Manning Formula = Q = **(do rest of formula)**

Values of "n" to be used in the Manning Formula shall be as shown in Design Aid No. 12. The minimum size storm sewer size shall be twelve (12) inches in diameter (fifteen (15) inches for CMP).

Storm sewers and inlets shall be of sufficient capacity to adequately carry the anticipated runoff from the design storm. Capacity shall be rated at either inlet or outlet control, whichever condition indicates the least capacity. The drainage system and appurtenant storm inlets shall commence at all locations where the allowable street capacity for the conveyance of storm water runoff is exceeded or where there is a possibility of ponding.

All storm drainage systems shall be designed so as to maintain a minimum velocity of flow of three (3) feet per second and a maximum velocity of fifteen (15) feet per second when flowing full. All systems discharging at a velocity in excess of five (5) feet per second shall be designed with an acceptable energy dissipating structure.

8. Depth. All storm drainage lines shall have a minimum cover of eighteen (18) inches where practical. Cover may be decreased to avoid conflicts or on short laterals, as approved by the County Engineer. Special bedding and backfill may be required where cover is less than eighteen (18) inches.

9. Curb Inlet, Junction Boxes and Other Points of Entry. In general, curb inlets shall be installed at intersections and as required at intermediate points to limit gutter flow width during runoff occurring from the design peak discharge from the tributary watershed area to that which will not encroach on the following center width of streets:

Thoroughfare Streets	24 feet
Collector/Service Streets	14 feet
Local Streets	10 feet

Because of the potential for street debris to clog inlets and to reflect potential cross section changes due to resurfacing, inlet capacity shall be rated at eighty (80) percent of the theoretical inlet capacity unless otherwise approved by the County Engineer.

Design shall provide that the hydraulic gradient at any opening through which surface water may enter (or backflow from) the system is 0.5 foot or greater below the opening elevation. The hydraulic gradient elevation is defined as:

a. Invert elevation of the outlet channel (pipe) of the structure.

b. Plus depth (diameter) of outlet channel (pipe).

c. Plus "h" calculated in accordance with Design Aid No. 13, except for structures where 50 percent or more of the discharge enters the structure from the surface "h" shall be calculated as = V /64.

The hydraulic gradient elevation shall be calculated at the entrance to the outlet line of each structure.

The crown(s) of pipe(s) entering a structure shall be at or above the crown of the pipe exiting from the structure to provide a minimum fall of the invert in the structure of 0.2 feet for straight flow through the structure or 0.5 feet fall for all other types of flow (bends more than 22.5 degrees deflection angle, multiple lines entering, enlargement transition, etc.) through the structure.

10. Open Channels. Unless in a one hundred (100) year designated floodplain or a critical area as determined by the County Engineer, open channels shall be designed for the ten (10) year frequency storm. Open channels shall be sized to adequately carry the design rate of flow without damage. Whenever practical, the channel shall be characterized as slow flowing, be wide and shallow, and be natural in its appearance and functioning.
Channel capacities shall be computed using the Manning Formula for uniform flow.

Design flow rates shall be carried within the confines of the open channel with a minimum allowable freeboard of 1.0 foot measured from the water surface to the top of bank.

Pipe culverts, box culverts, and other structures entering channels shall not project into the normal waterway area.

Channel design shall include lining or treatment of the invert and sides as required to minimize erosion. Minimum treatment shall including seeding. Channel inverts and sides shall be lined in accordance with the following table:

Mean Flow Velocity	Type of Lining
Less than 3 F.P.S.	Seeded
3 to 5 F.P.S.	Sod, staked
5 to 10 F.P.S.	Stone riprap (15" Min. Thickness)
10 to 15 F.P.S.	Grouted stone riprap, gabion revetment or concrete paved
Over 15 F.P.S.	Concrete paved or sound in-situ rock

Lining materials having equivalent erosion control properties to those shown in the foregoing table may be used in lieu thereof with the approval of the County Engineer.

Channel sections shall be compatible with the type of lining and maintenance practical to be used. Side slopes shall be as flat as practical. Side slopes of 3:1 shall be considered a normal maximum. Under special circumstances where acceptable lining material is to be utilized, slopes of 2:1 may be considered. Such use in the channel design shall be only where approved by the County Engineer. Friction factors used in design shall consider the type of lining and are listed in Design Aid No. 12.

Alignment changes shall be achieved by curves having a minimum radius of:

$$R = \frac{V\,W}{8D}$$

R = Minimum radius of centerline in feet.

V = Average velocity of flow in feet/sec.

W = Width of channel at water surface in feet.

D = Depth of flow in feet.

Lining height on the outside (concave) side of curves shall be increased by:

$$y = \frac{D}{4}$$

y = Increased vertical height of lining in feet.

Increased lining height shall be transitioned from y to zero feet over a minimum distance of

a. 30 (y) feet downstream from the point of tangency (p.t.)

b. 10 (y) feet upstream from the point of curvature (p.c.)

11. Natural Channels. Shall conform to the criteria for improved channels except:

a. Mean flow velocity may be 5 feet/sec without lining.

b. Freeboard requirements may be satisfied by dedication of an easement to the freeboard elevation plus 1.0 foot vertically.

12. Culvert. Culverts under major and minor arterials shall have sufficient capacity to pass the runoff from the appropriate design storm considering twenty (20) percent of the inlet opening plugged.

The following design criteria shall be utilized for all culvert design:

a. The culvert including inlet and outlet structures shall properly take care of water, bed-load and debris at all stages of flow.

b. Inlet. Culvert inlets shall be designed to minimize entrance and friction losses. Inlets shall be provided with either flared-end sections or headwalls with wingwalls. Projecting ends will not be acceptable. For large structures, provisions shall be made to resist possible structural failure due to hydrostatic uplift forces.

c. Outlets. Culvert outlets shall be designed to avoid sedimentation, undermining of the culvert, and erosion of the downstream channel. Outlets shall be provided with either flared-end sections or headwalls with wingwalls. Projecting outlets will not be acceptable. Additional outlet control in the form of riprap, channel shaping, etc., may be required where excessively high discharge velocities occur.

d. Slopes. Culvert slopes should be such that neither silting nor excessive velocities and scour occur. Generally, the minimum slope of culverts shall be limited to 0.005.

e. Headwater. Generally, the headwater to diameter ratio (HW/D) should not exceed those recommended as follows:

Storm Frequency	HW/D
10 Year	≤ 1.0
25 Year	≤ 1.2
50 Year	≤ 1.5

100 Year	≤ 1.5

f. Tailwater. The depth of tailwater at the outlet shall be subject to the criteria set forth for headwater.

g. Hydraulic Design. Culverts shall be analyzed to determine whether discharge is controlled by inlet or outlet conditions for design storm discharge. The value of the roughness coefficient (n) used shall not be less than those specified in Design Aid No. 12.

h. Structural Design. The structural design of culverts, whether pipe or concrete box, shall be sufficient for the situation anticipated to be encountered at the site of the proposed work. Such design shall conform fully to all requirements set forth in this criteria and in the Technical Specifications of the Clay County Highway Department/PWD and shall be as approved by the County Engineer.

D. PERMANET DRAINAGE EASEMENTS. Permanent drainage easements are required to provide adequate access for construction, inspection, and maintenance of all storm drainage system components. All easements shall be dedicated to the County. For new subdivisions, all required easements and setbacks shall be shown on the final plat recorded with the Recorder of Deeds.

Drainage easements shall have minimum widths as described below. A wider easement width may be required at structures or as determined by the County Engineer.

1. Storm Sewer. Easements for storm sewers shall be either fifteen (15) feet wide or the outside dimension of the conduit plus ten (10) feet (centered on the conduit), which ever is greater. A wider easement may be required if the depth of cover exceeds four (4) feet.

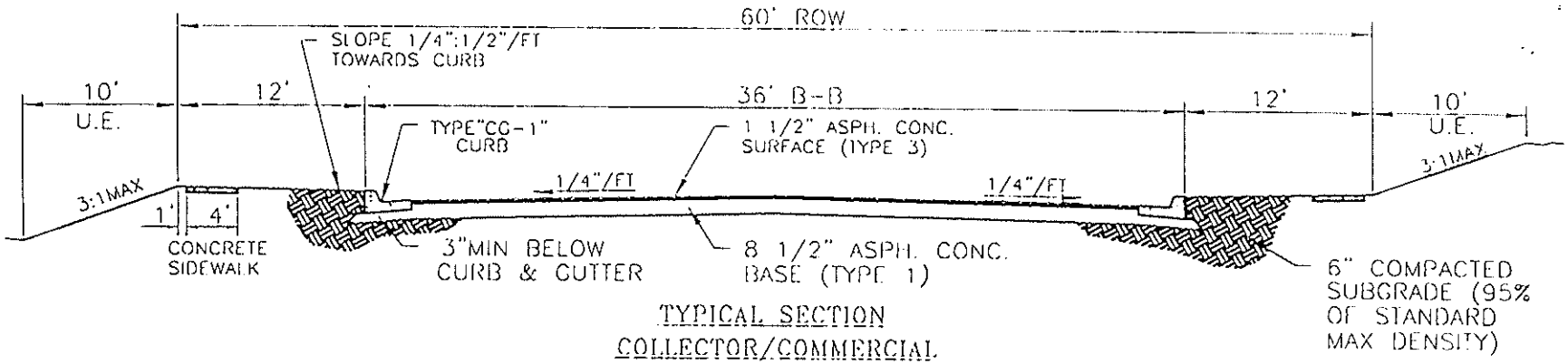
2. Improved Open Channel. Easements for improved open channels shall be as wide as the top bank width plus ten (10) feet on each side, and shall be continuous to the end of the channel.

3. Natural Open Channel. Easements for natural open channels shall be the area between the high bank lines of the channel, plus additional width on each side of the channel as deemed necessary by the County to allow access for maintenance equipment. The minimum width for a natural open channel easement is thirty (30) feet.

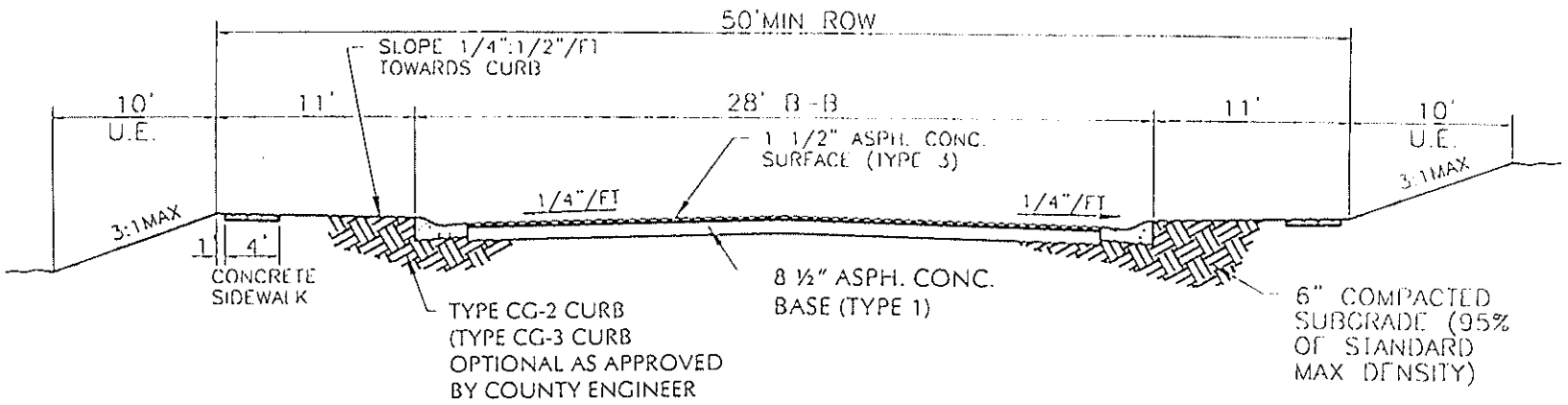
County of Clay
HIGHWAY
DEPARTMENT/PWD

TYPICAL SECTIONS LOCAL STREET
& COLLECTOR/COMMERCIAL

DC-1



TYPICAL SECTION
COLLECTOR/COMMERCIAL

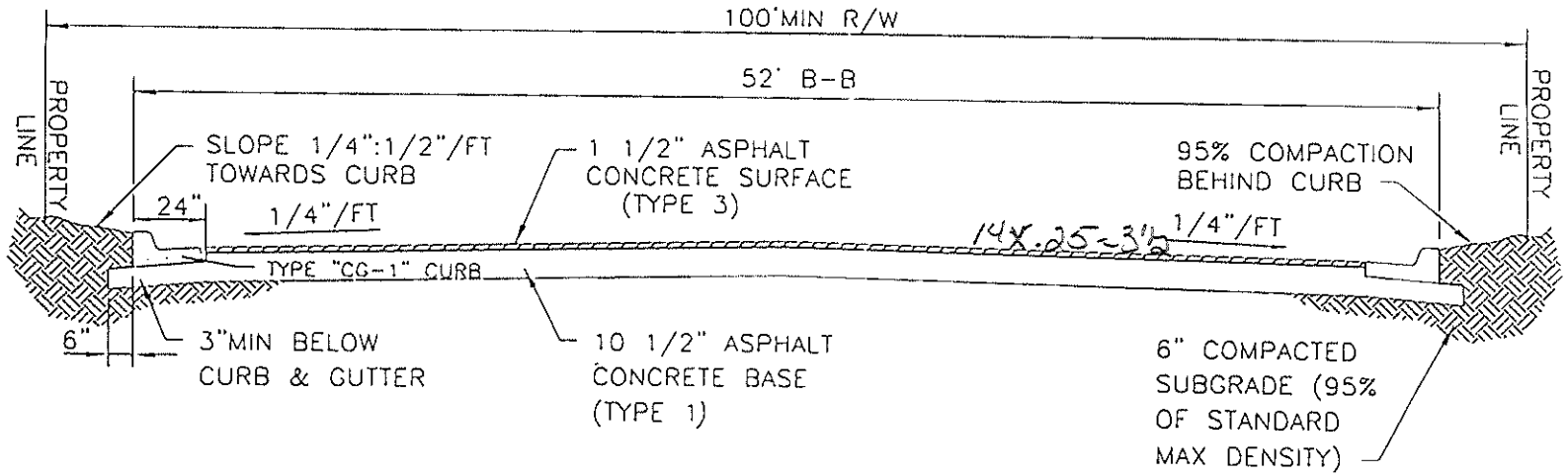


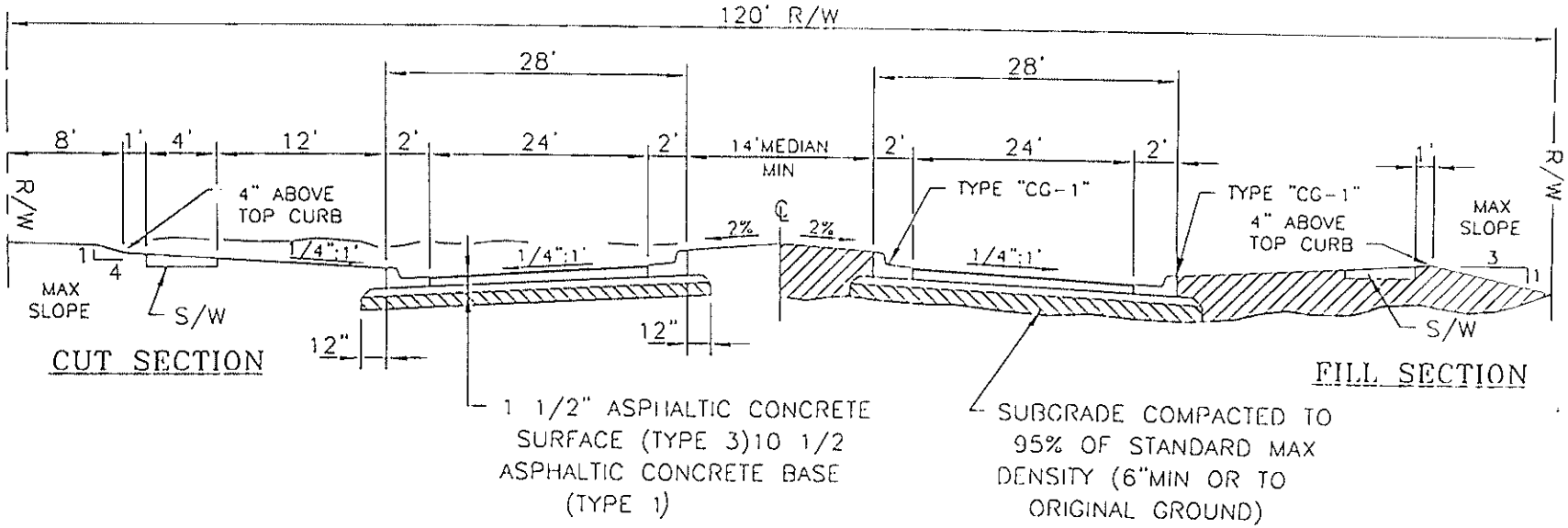
TYPICAL SECTION
LOCAL STREET

County of Clay
HIGHWAY
DEPARTMENT/PWD

TYPICAL SECTIONS MINOR AND MAJOR ARTERIAL

DC-2





County of Clay
HIGHWAY
DEPARTMENT/PWD

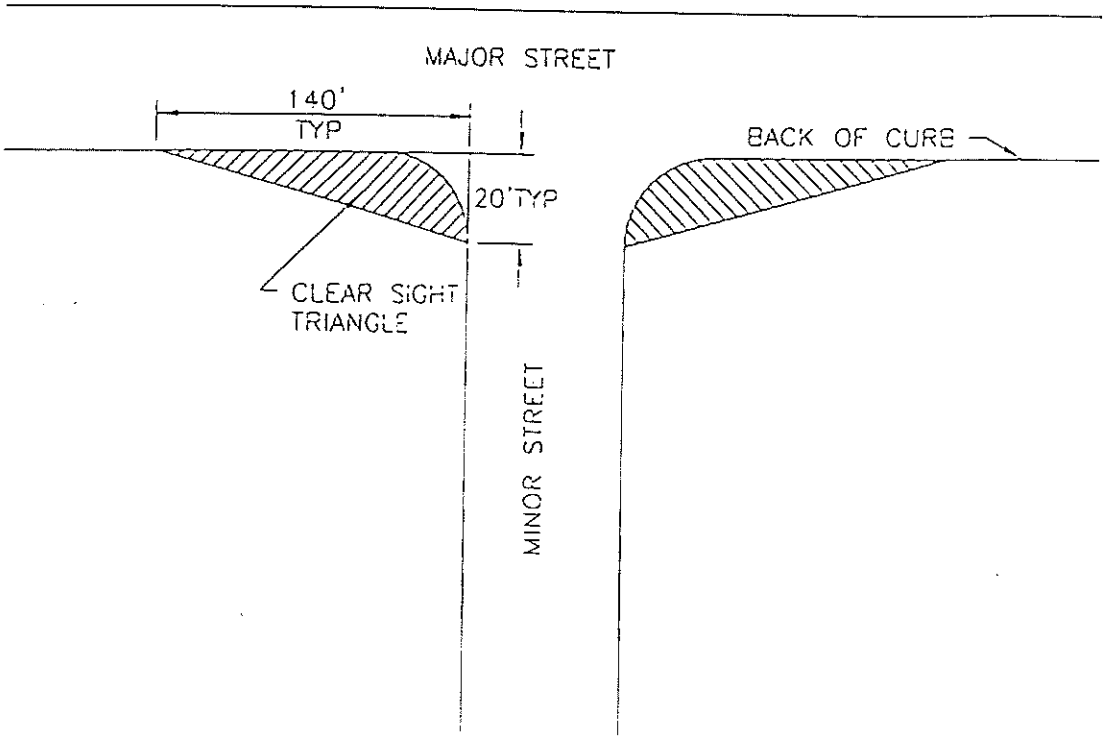
STREET PAVEMENT
TYPE

DC-3

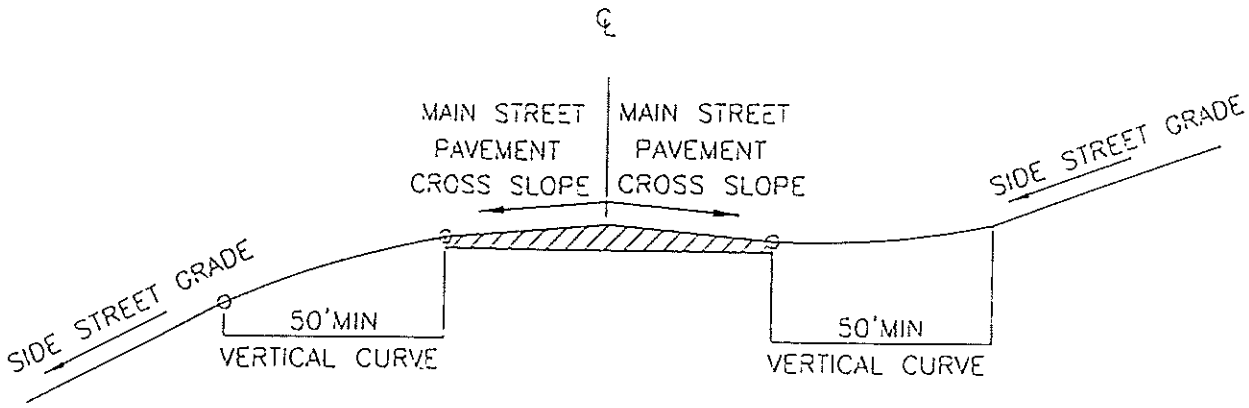
PAVEMENT TYPES

STREET CLASSIFICATIONS	OPTION 1	OPTION 2
LOCAL	6"min. portland cement concrete pavement. 6"min. compacted subgrade 95% of standard max. density.	1 1/2" type 3 asphaltic concrete surface. 6 1/2" min. asphaltic concrete base course (type 1)
COLLECTOR / COMMERCIAL	7" min. portland cement concrete pavement 6" min. compacted subgrade 95% of standard max. density	1 1/2" type 3 asphaltic concrete surface 8 1/2" min. asphaltic concrete base course (type 1) 6" min. compacted subgrade 95% of standard max. density
MINOR ARTERIAL	9" min. portland cement concrete pavement 6" min. compacted subgrade 95% of standard max. density	1 1/2" type 3 asphaltic concrete surface 10 1/2" min. asphaltic concrete base course (type 1) 6" min. compacted subgrade 95% of standard max. density
MAJOR ARTERIAL	9" min. portland cement concrete pavement 6" min. compacted subgrade 95% of standard max. density	1 1/2" type 3 asphaltic concrete surface 10 1/2" min. asphaltic concrete base course (type 1) 6" min. compacted subgrade 95% of standard max. density

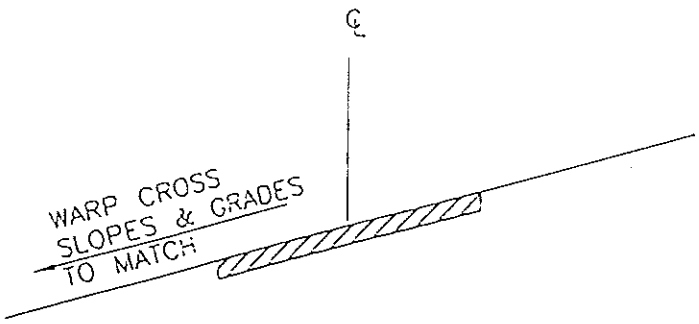
NOTE:
PAVEMENT TYPE OPTIONS TO BE CONSIDERED SHALL BE SUBMITTED TO THE COUNTY ENGINEER FOR APPROVAL.



County of Clay HIGHWAY DEPARTMENT/PWD	INTERSECTION CLEAR SIGHT TRIANGLE	DC-4

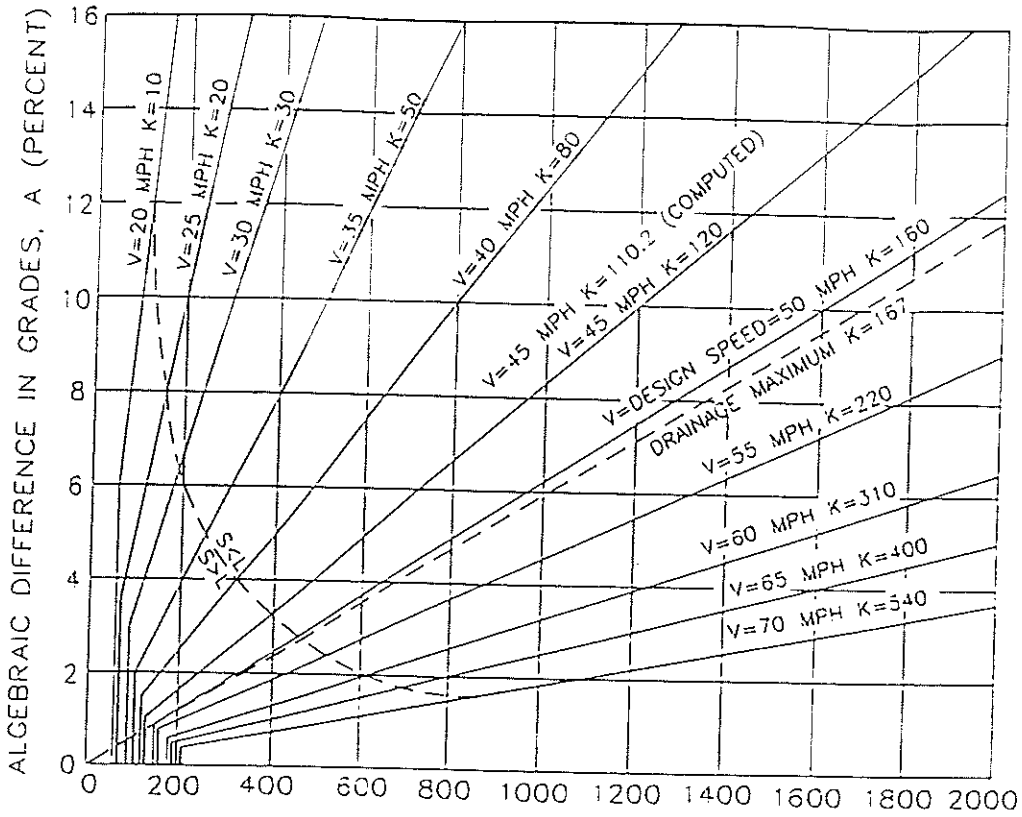


MAIN STREET SECTION & SIDE STREET PROFILE
INTERSECTION OF LESSER WITH A GREATER FUNCTION STREET



THRU STREET SECTION AND PERPENDICULAR STREET PROFILE
INTERSECTION OF EQUAL FUNCTION STREETS.NCTION STREET

SEAL OF CLAY COUNTY MISSOURI	County of Clay HIGHWAY DEPARTMENT/PWD	INTERSECTION VERTICAL ALIGNMENT	DC-5



DESIGN SPEED (MPH)	STOPPING SIGHT DISTANCE (FT.)	K VALUE
20	125	10
25	150	20
30	200	30
35	250	50
40	325	80
45	400	120
50	475	160
55	550	220
60	650	310
65	725	400
70	850	540

$S < L : L = \frac{AS^2}{1398}$

$S > L : L = 2S - \frac{1398}{A}$

L=LENGTH OF VERTICAL CURVE

A=ALGEBRAIC DIFFERENCE IN GRADES

S=STOPPING SIGHT DISTANCE

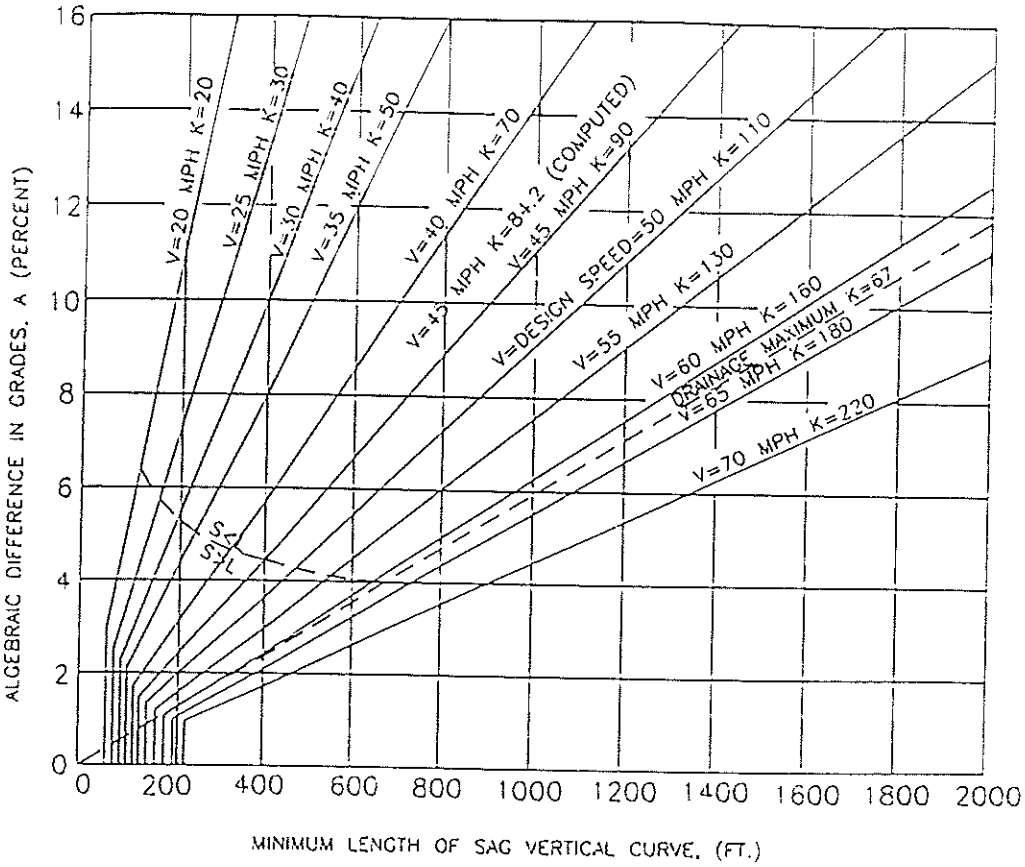
DESIGN CONTROLS FOR CREST VERTICAL CURVES

STOPPING SIGHT DISTANCE

FIGURE III-39

SOURCE: 1984 AASHTO, PAGE 308

County of Clay HIGHWAY DEPARTMENT/PWD	MINIMUM STOPPING SIGHT DISTANCE	DC-6



DESIGN SPEED (MPH)	STOPPING SIGHT DISTANCE (FT.)	K VALUE
20	125	20
25	150	30
30	200	40
35	250	50
40	325	70
45	400	90
50	475	110
55	550	130
60	650	160
65	725	180
70	850	220

$S < L : L = \frac{AS^2}{1398}$

$S > L : L = 2S - \frac{1398}{A}$

L=LENGTH OF VERTICAL CURVE

A=ALGEBRAIC DIFFERENCE IN GRADES

S=STOPPING SIGHT DISTANCE

DESIGN CONTROL FOR SAG VERTICAL CURVES

STOPPING SIGHT DISTANCE

FIGURE III–40

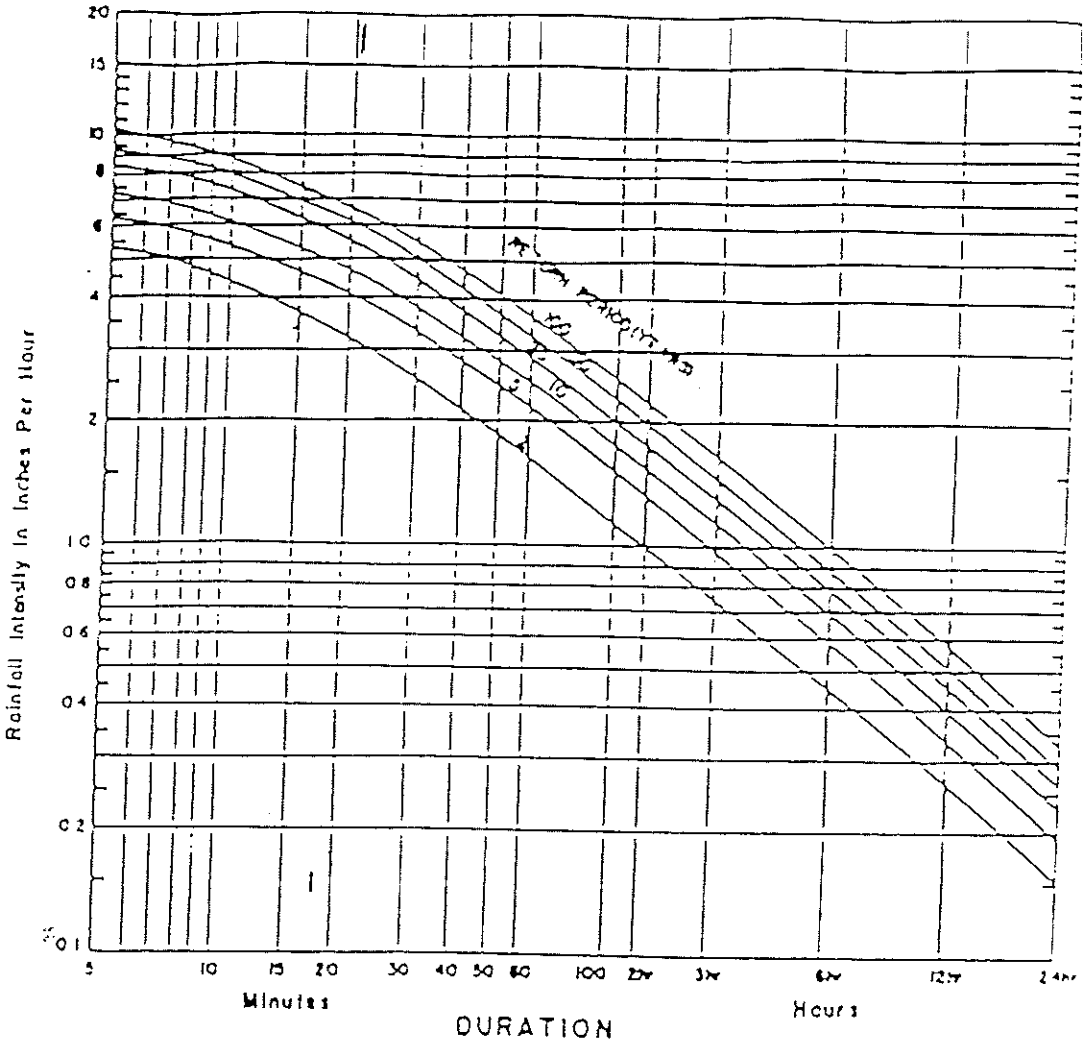
SOURCE: 1984 AASHTO, PAGE 314

SEAL OF CLAY COUNTY MISSOURI	County of Clay HIGHWAY DEPARTMENT/PWD	MINIMUM STOPPING SIGHT DISTANCE
		DC-7

INTENSITY-DURATION-FREQUENCY

KANSAS CITY, MISSOURI

1896 - 1972



REFERENCES

1. NOAA Technical Memorandum NWS HYDRO-35 National Oceanic and Atmospheric Administration Of The National Weather Service, Department Of Commerce Silver Spring, Md. June 1977.

2. Technical Paper No.40, Rainfall Frequency Atlas for Durations From 30mins. to 24hrs. and Return Periods, From 1yr. to 100yrs. US Weather Bureau, Department of Commerce, Washington, D.C., January 1963.

3. Design Of Urban Highway Drainage-State of the Art FHWA-TS-79-225 US Department of Transportation Federal Highway Administration, Washington, D.C., August 1979.

DESIGN AIDE FOR CALCULATING RAINFALL INTENSITY
KANSAS CITY METROPOLITAN AREA

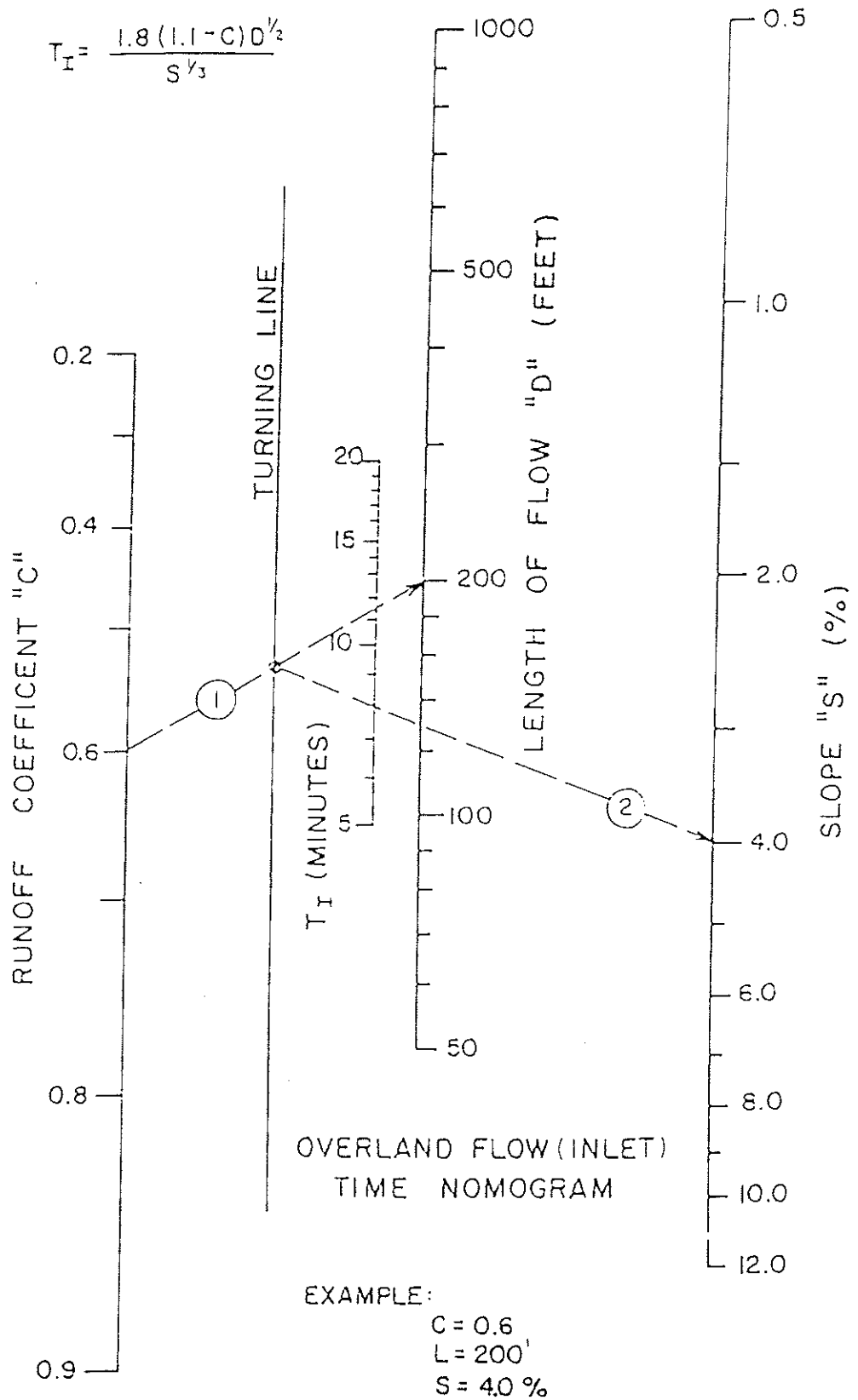
Return Period	Equation 1 $5 \leq Tc \leq 15$	Equation 2 $15 < Tc \leq 60$
2 yr.	$i = \frac{119}{Tc - 17}$	$i = \frac{134}{Tc - 21.4}$
5 yr.	$i = \frac{154}{Tc - 18.8}$	$i = \frac{182}{Tc - 25}$
10 yr.	$i = \frac{175}{Tc - 18.8}$	$i = \frac{214}{Tc - 26.7}$
25 yr.	$i = \frac{203}{Tc - 18.8}$	$i = \frac{262}{Tc - 28.8}$
50 yr.	$i = \frac{233}{Tc - 19.8}$	$i = \frac{296}{Tc - 29.6}$
100 yr.	$i = \frac{256}{Tc + 19.8}$	$i = \frac{331}{Tc - 30}$

i = Rainfall intensity in inches per hour.

Tc = Time of concentration in minutes.

Note: Table C is a design aide for use with computers to calculate rainfall intensity in the Kansas City Metropolitan Area using the Steel Formula.

$$T_I = \frac{1.8(1.1-C)D^{1/2}}{S^{1/3}}$$



OVERLAND FLOW (INLET) TIME NOMOGRAM

EXAMPLE:

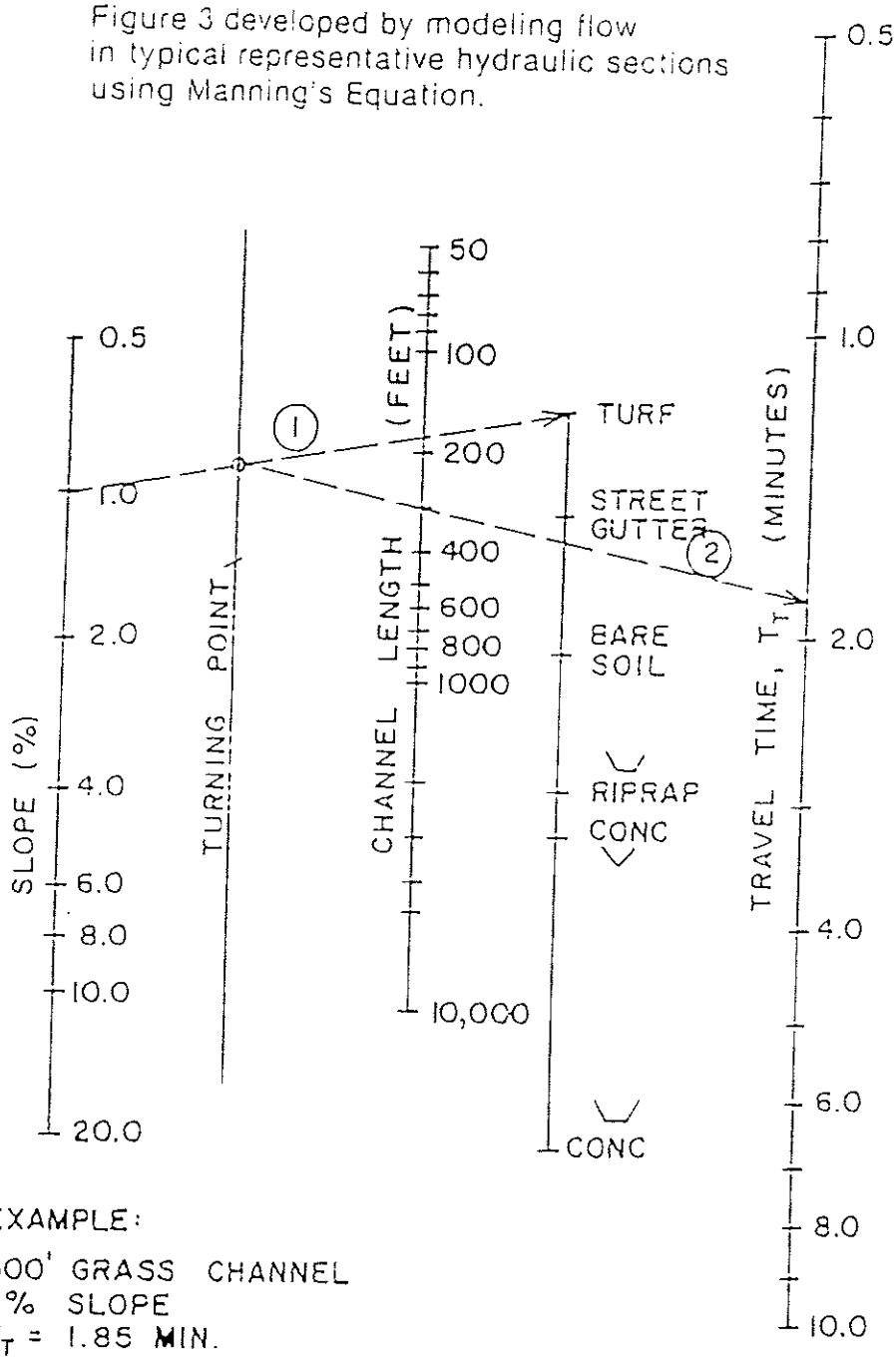
C = 0.6
L = 200'
S = 4.0 %

FROM FIG. -1, TI = 8 Minutes

County of Clay HIGHWAY DEPARTMENT/PWD	FLOW (INLET) TIME NOMOGRAM	DC-10

CHANNEL FLOW
TIME NOMOGRAM

Figure 3 developed by modeling flow in typical representative hydraulic sections using Manning's Equation.



EXAMPLE:

300' GRASS CHANNEL
1% SLOPE
T_T = 1.85 MIN.

(1) Connect Slope & Channel Condition to locate point on Turning Line

(2) Extend line from Turning Line through Channel Length, Read T_T

County of Clay HIGHWAY DEPARTMENT/PWD	CHANNEL FLOW TIME NOMOGRAM	DC-11

Table A

MANNING'S ROUGHNESS COEFFICIENT n

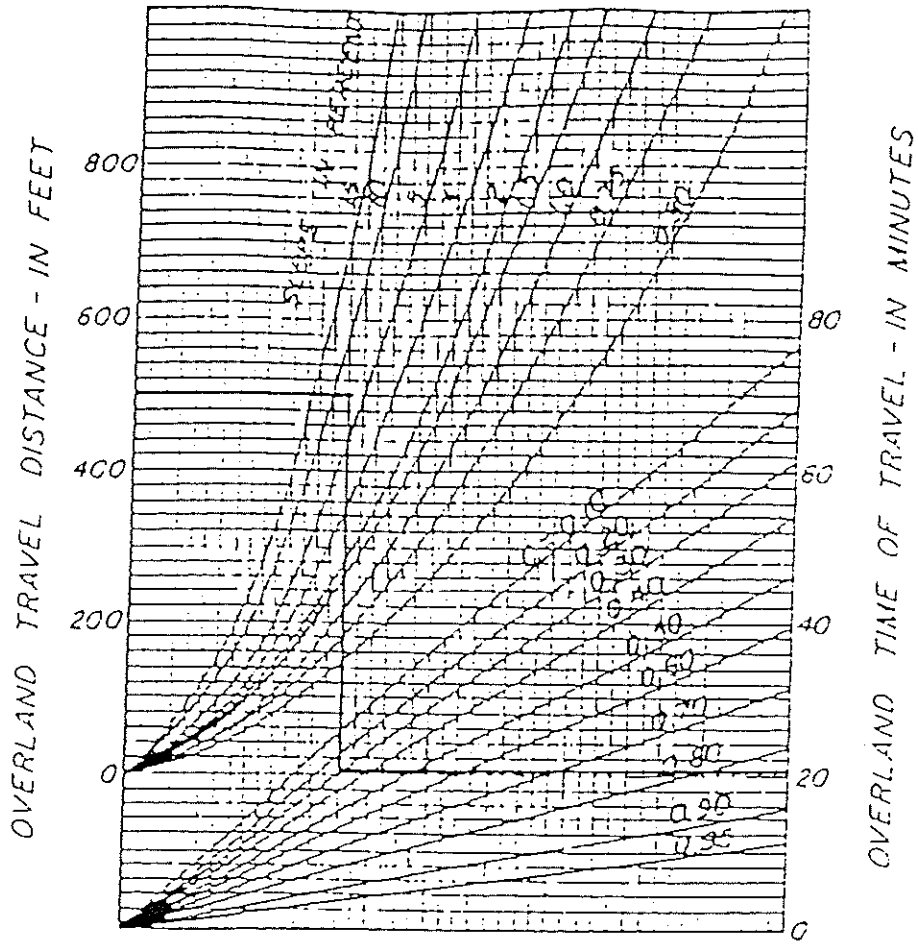
Type of Channel	n
Closed Conduits	
Reinforced Concrete Pipe	0.013
Reinforced Concrete Elliptical Pipe	0.013
Corrugated Metal Pipe:	
2⅔x½ in. Annular Corrugations unpaved - plain	0.024
2⅔x½ in. Annular Corrugations paved invert	0.021
3x1 in. Annular Corrugations unpaved - plain	0.027
3x1 in. Annular Corrugations paved invert	0.023
6x2 in. Corrugations unpaved - plain	0.033
6x2 in. Corrugations paved invert	0.028
Vitrified Clay Pipe	0.013
Asbestos Cement Pipe	0.012
Open Channels (Lined)	
Gabions	0.025
Concrete	
Trowel Finish	0.013
Float Finish	0.015
Unfinished	0.017
Concrete, bottom float finished, with sides of	
Dressed Stone	0.017
Random Stone	0.020
Cement Rubble masonry	0.025
Dry Rubble or Riprap	0.030
Gravel bottom, side of	
Random Stone	0.023
Riprap	0.033
Grass (Sod)	0.030
Riprap	0.035
Grouted Riprap	0.030
Open Channels (Unlined) Excavated or Dredged	
Earth, straight and uniform	0.027
Earth, winding and sluggish	0.035
Channels, not maintained, weeds & brush uncut	0.090
Natural Stream	
Clean stream, straight	0.030
Stream with pools, sluggish reaches, heavy underbrush	0.100
Flood Plains	
Grass, no brush	0.030
With some brush	0.090
Street Curbing	0.014

Table B

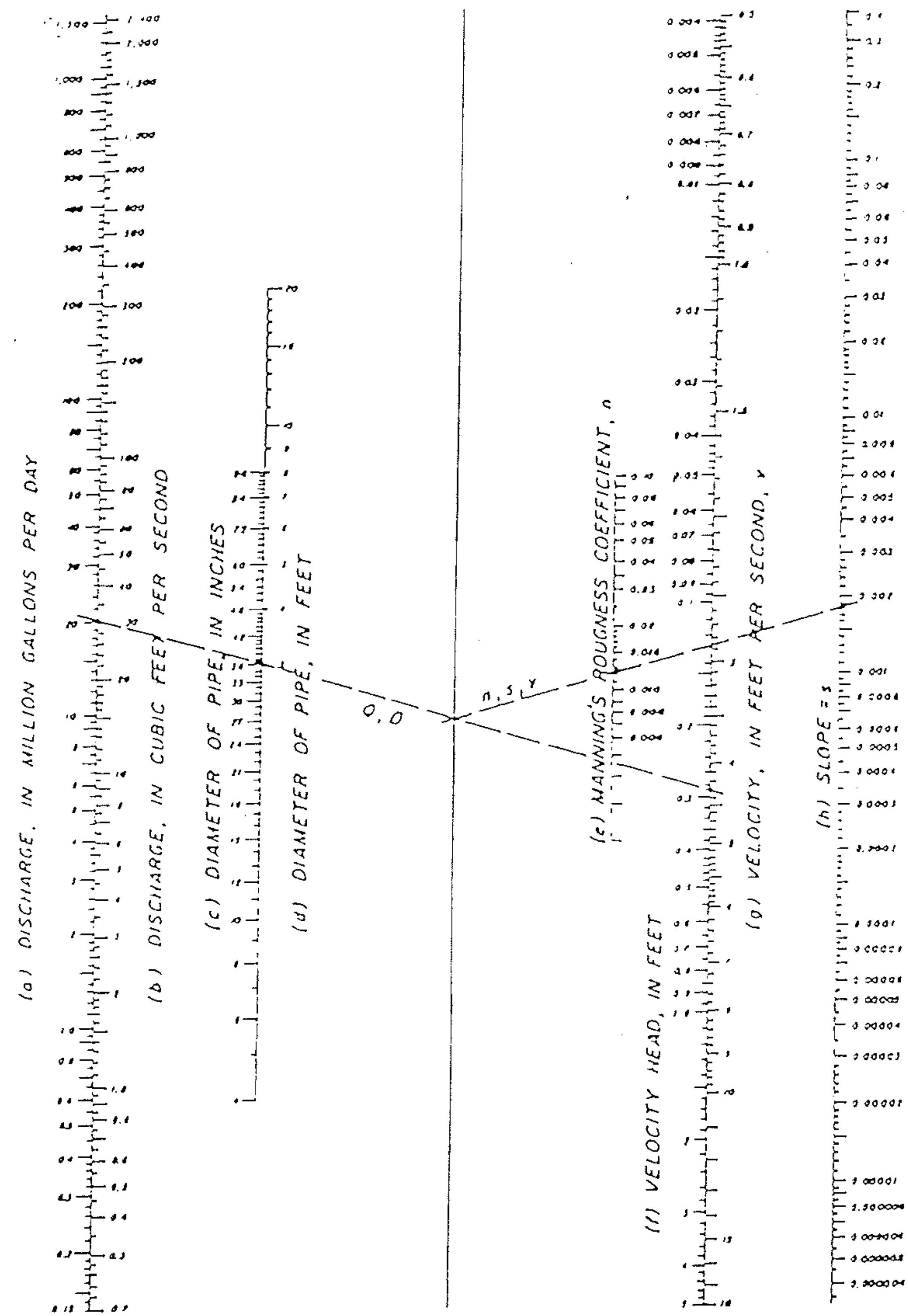
HEAD LOSS COEFFICIENT k

Condition	k
Manhole, junction boxes and inlets with shaped inverts:	
Thru flow	0.15
Junction	0.4
Contraction transition	0.1
Expansion transition	0.2
90 degree bend	0.4
45 degree and less bends	0.3
Culvert outlet	
Culvert inlets:	
Pipe, Concrete	
Projecting from fill, socket end (groove end)	0.2
Projecting from fill, sq. cut end	0.5
Headwall or headwall and wingwalls	
Socket end of pipe (groove end)	0.2
Square edge	0.5
Round (radius = 1/12D)	0.2
Mitered to conform to fill slope	0.7
Standard end section	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or-slope-tapered inlet	0.2
Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls square edge	0.5
Mitered to conform to fill slope, paved or unpaved slope	0.7
Standard end section	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or-slope-tapered inlet	0.2
Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square edged on 3 edges	0.5
Rounded on 3 edges to radius of 1/12 barrel dimension, or beveled edges on 3 sides	0.2
Wingwalls at 30° to 75° to barrel	
Square edged at crown	0.4
Crown edge rounded to radius of 1/12 barrel dimension, or beveled top edge	0.20

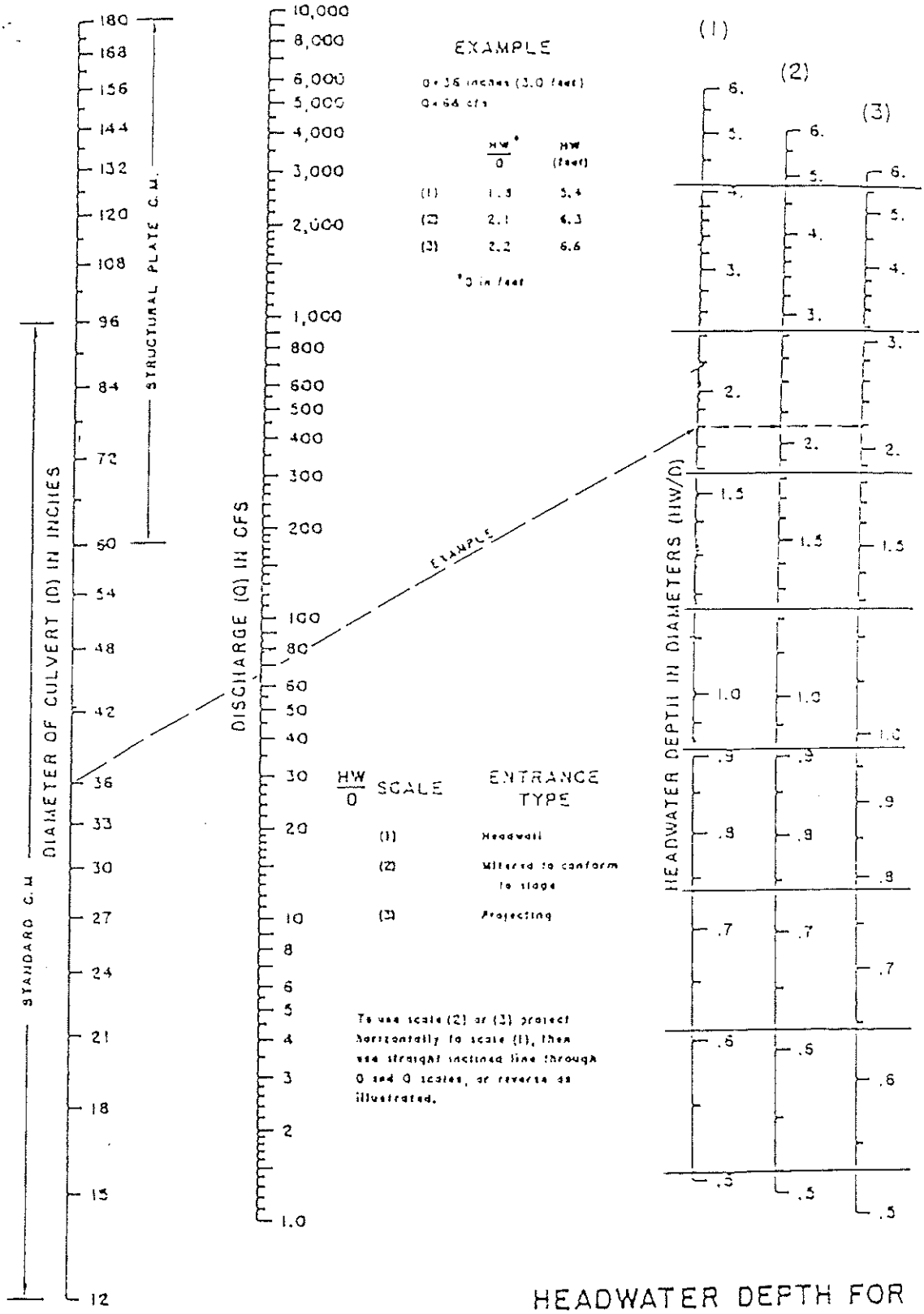
Note: When 50 percent or more of the discharge enters the structure from the surface "k" shall be 1.0. See 5603.2.3.



Relation of overland time of travel to overland travel distance, average overland slope, and coefficient C, for use in Rational Method.

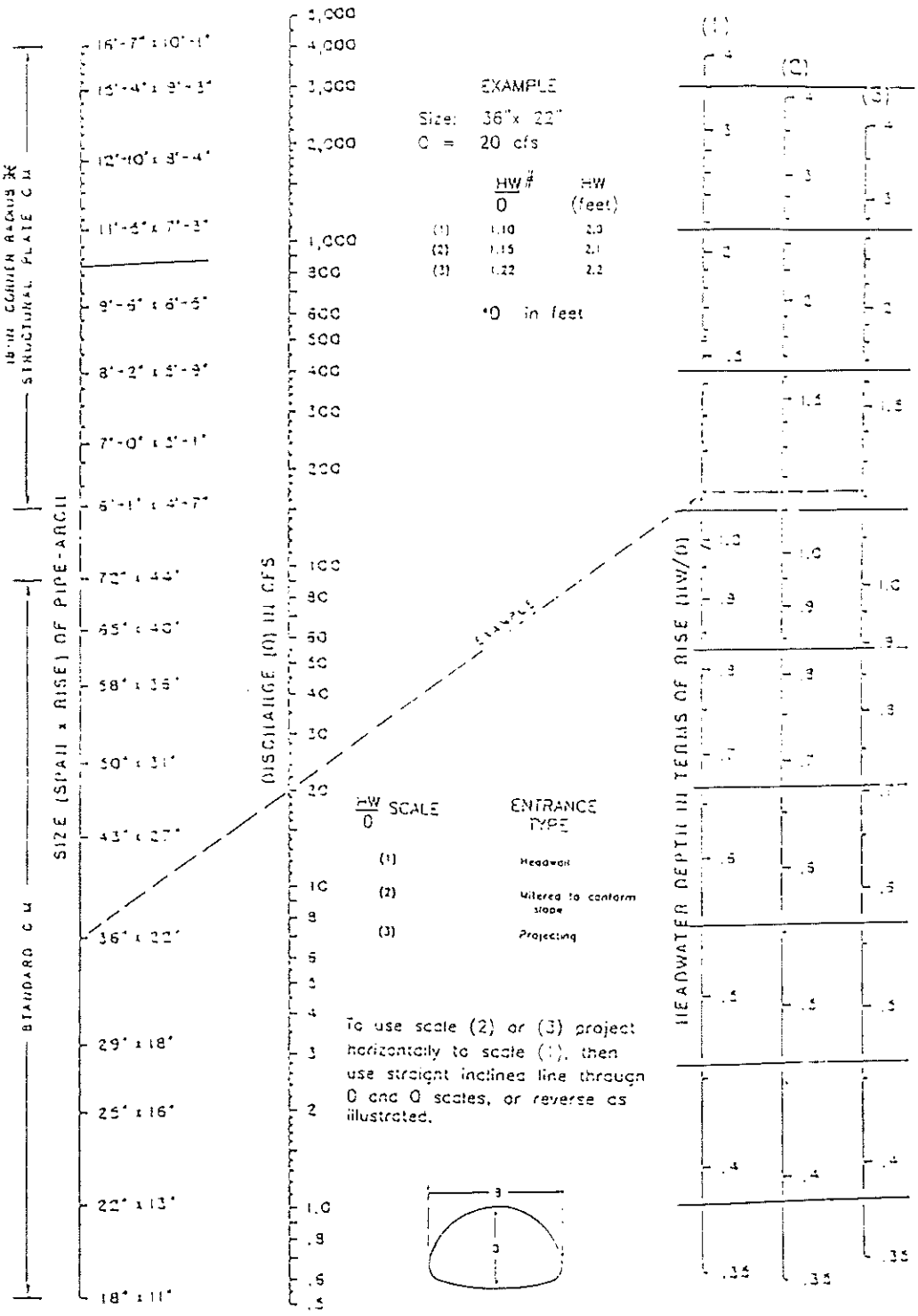


County of Clay HIGHWAY DEPARTMENT/PWD	NOMOGRAPH FOR FLOW IN ROUND PIPE MANNING'S FORMULA	DC-15



HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

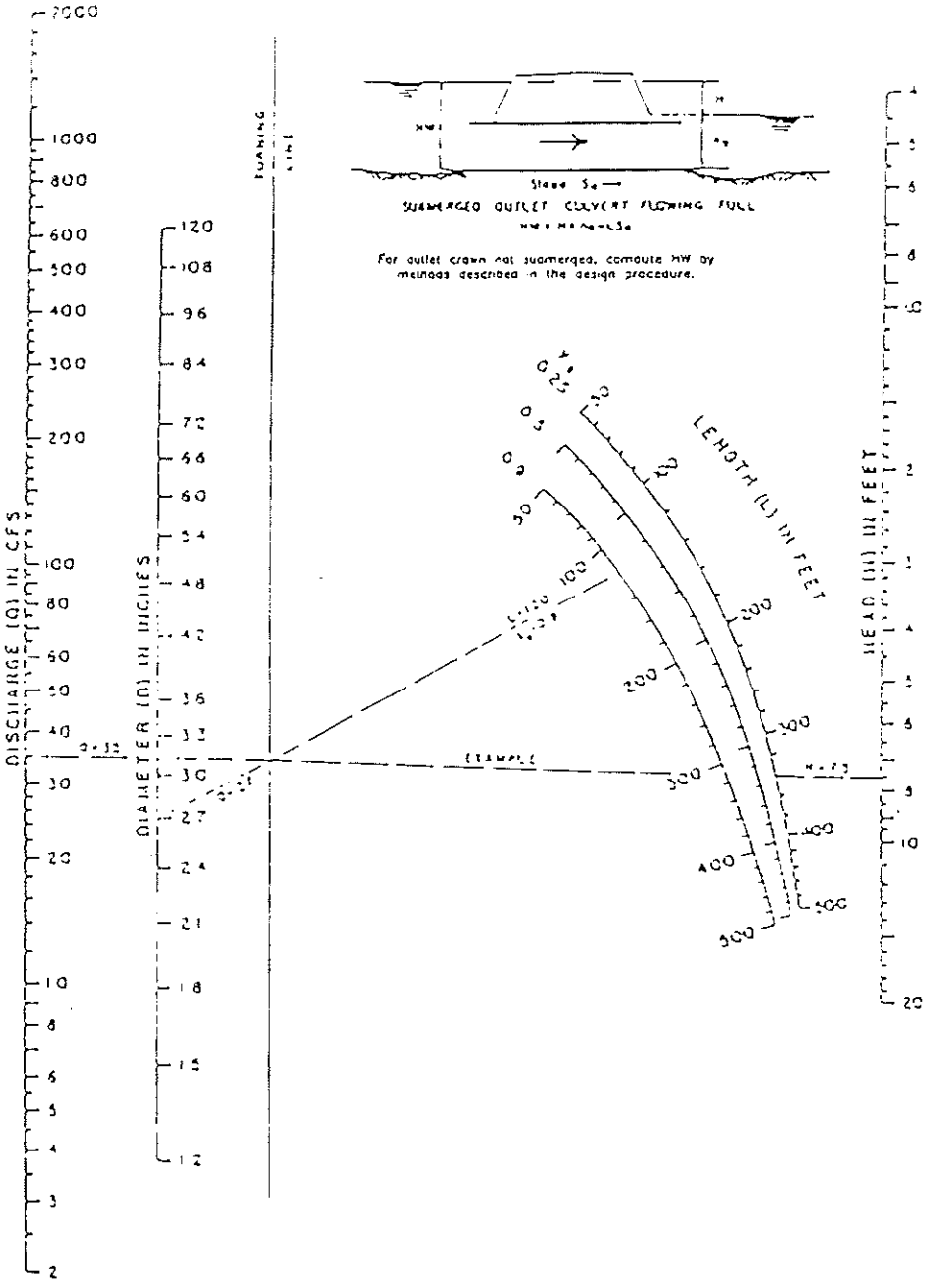
County of Clay HIGHWAY DEPARTMENT/PWD	HEADWATER DEPTH FOR C.M. PIPE CULVERTS W/INLET CONTROL	DC-16



* ADDITIONAL SIZES NOT DIMENSIONED ARE LISTED IN FABRICATOR'S CATALOG

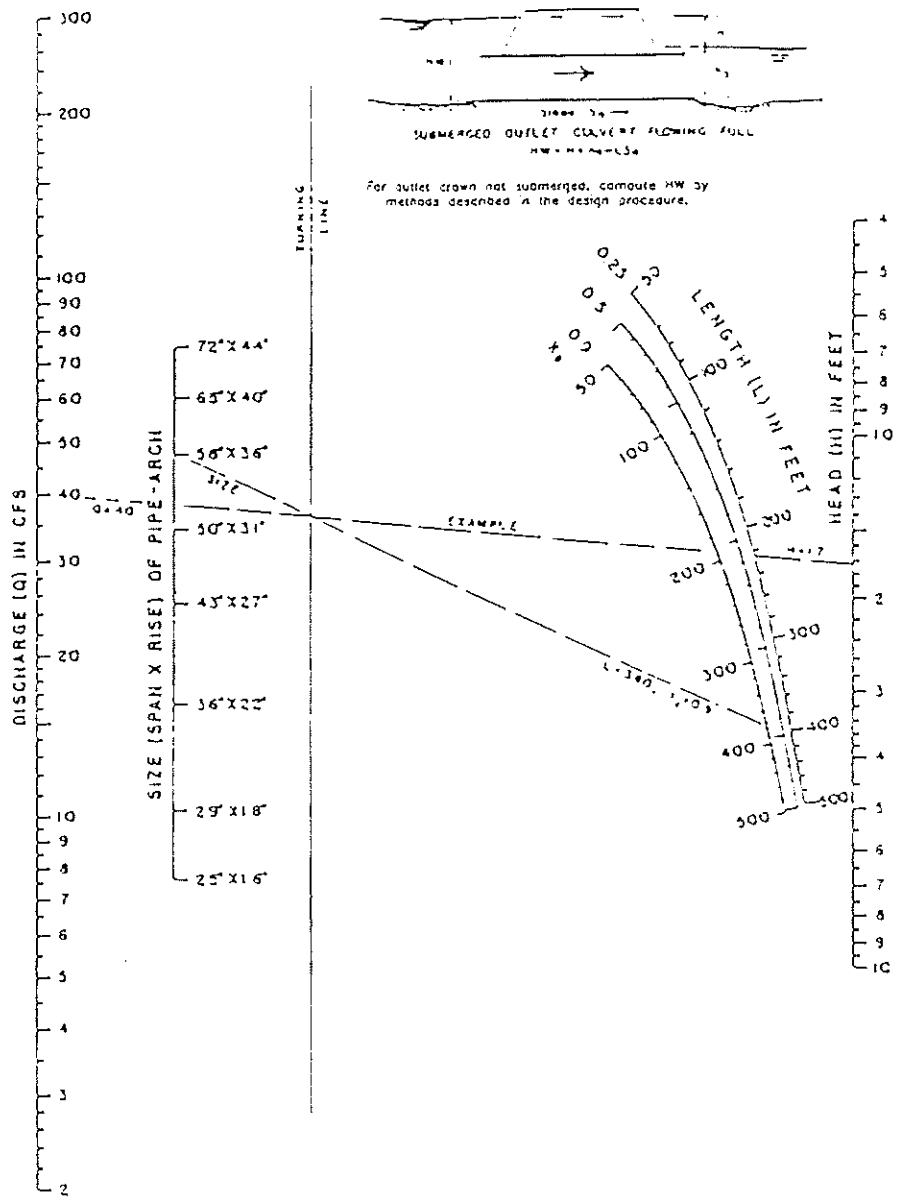
BUREAU OF PUBLIC ROADS JAN. 1963

SEAL OF CLAY COUNTY MISSOURI	County of Clay HIGHWAY DEPARTMENT/PWD	HEADWATER DEPTH FOR C.M. PIPE ARCH CULVERTS W/INLET CONTROL
		DC-17



BUREAU OF PUBLIC ROADS JAN. 1963

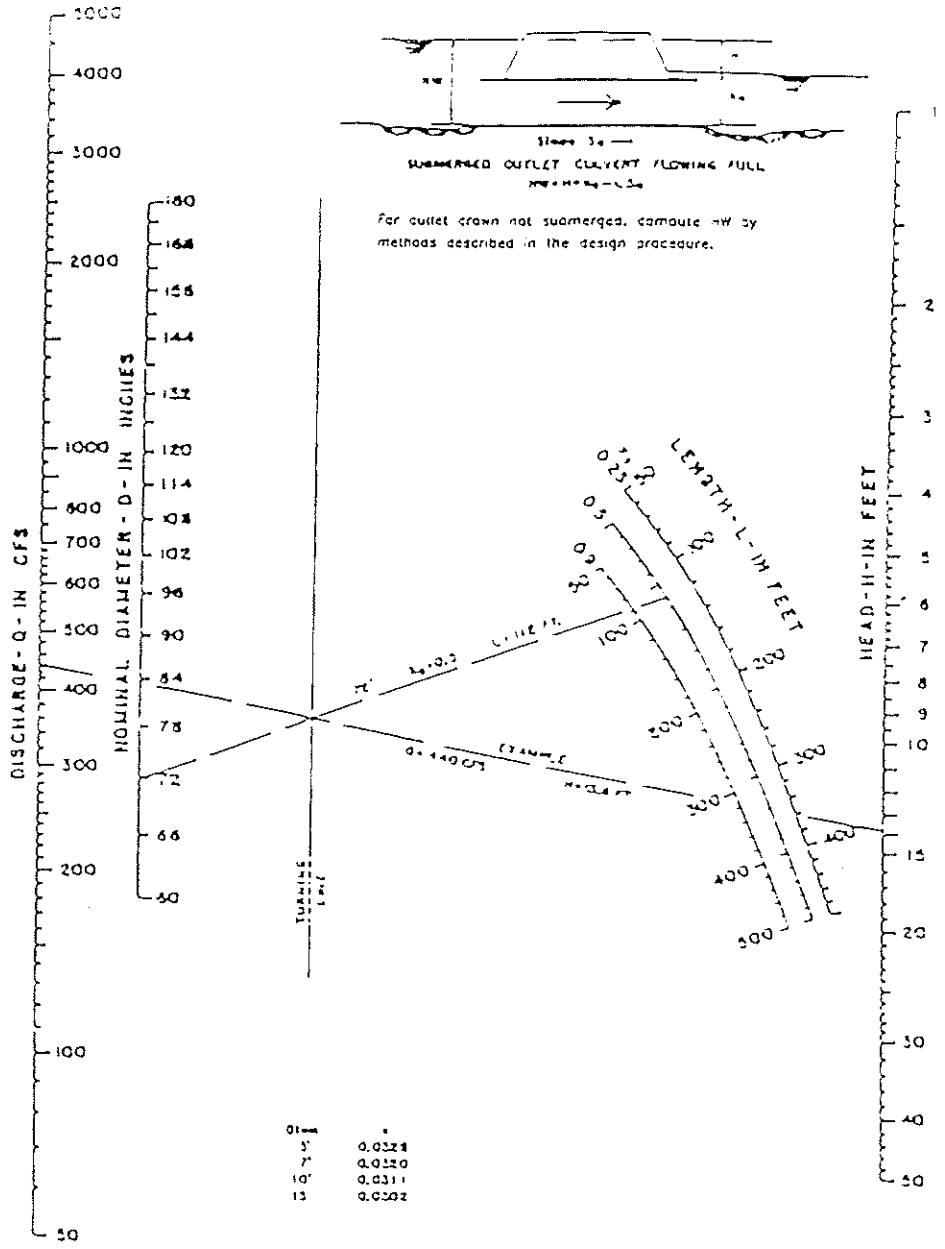
County of Clay HIGHWAY DEPARTMENT/PWD	HEAD FOR STANDARD C.M. PIPE ARCH CULVERTS FOLLOWING FULL n=0.024	DC-18



HEAD FOR
STANDARD C. M. PIPE-ARCH CULVERTS
FLOWING FULL
n=0.024

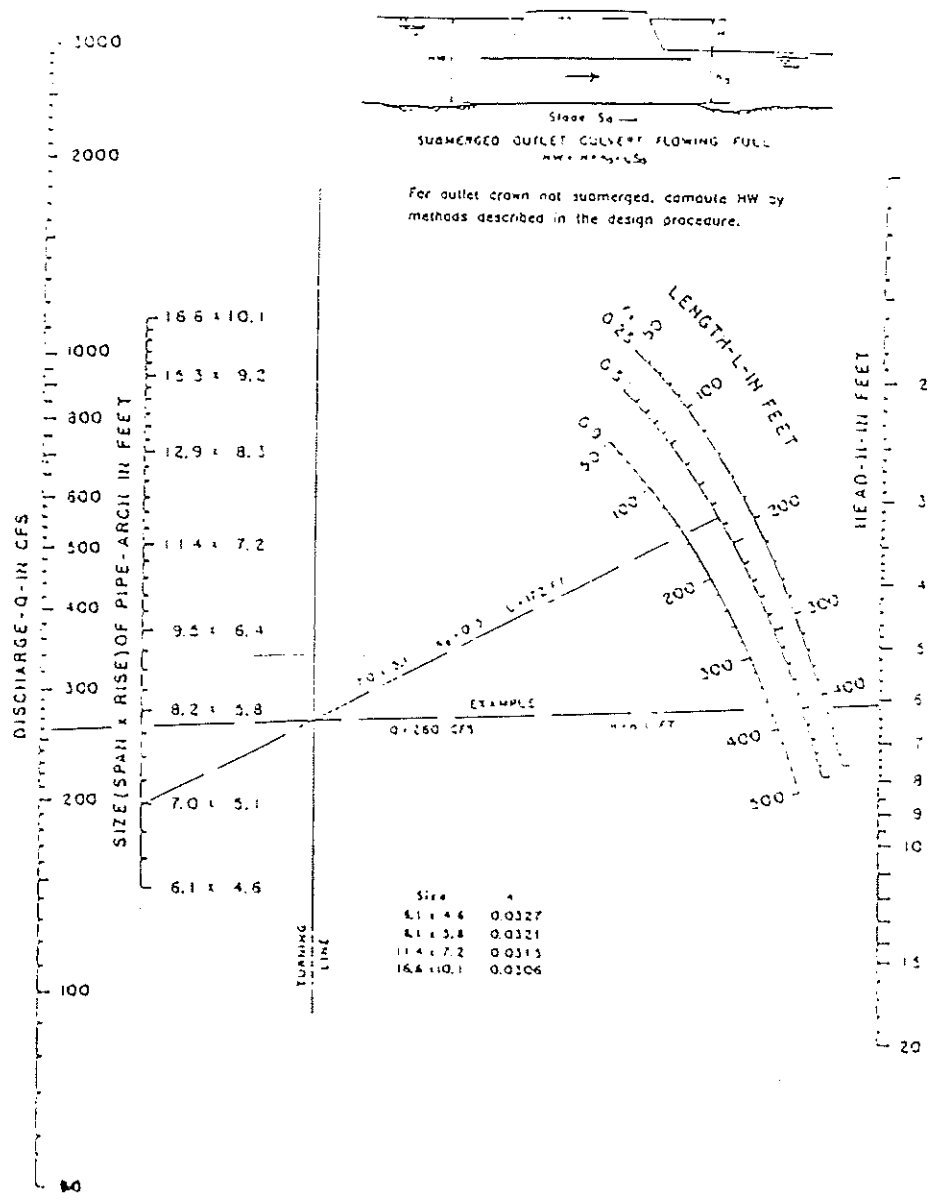
BUREAU OF PUBLIC ROADS JAN. 1963

County of Clay HIGHWAY DEPARTMENT/PWD	HEAD FOR STANDARD C.M. PIPE ARCH CULVERTS FOLLOWING FULL n=0.024	DC-19



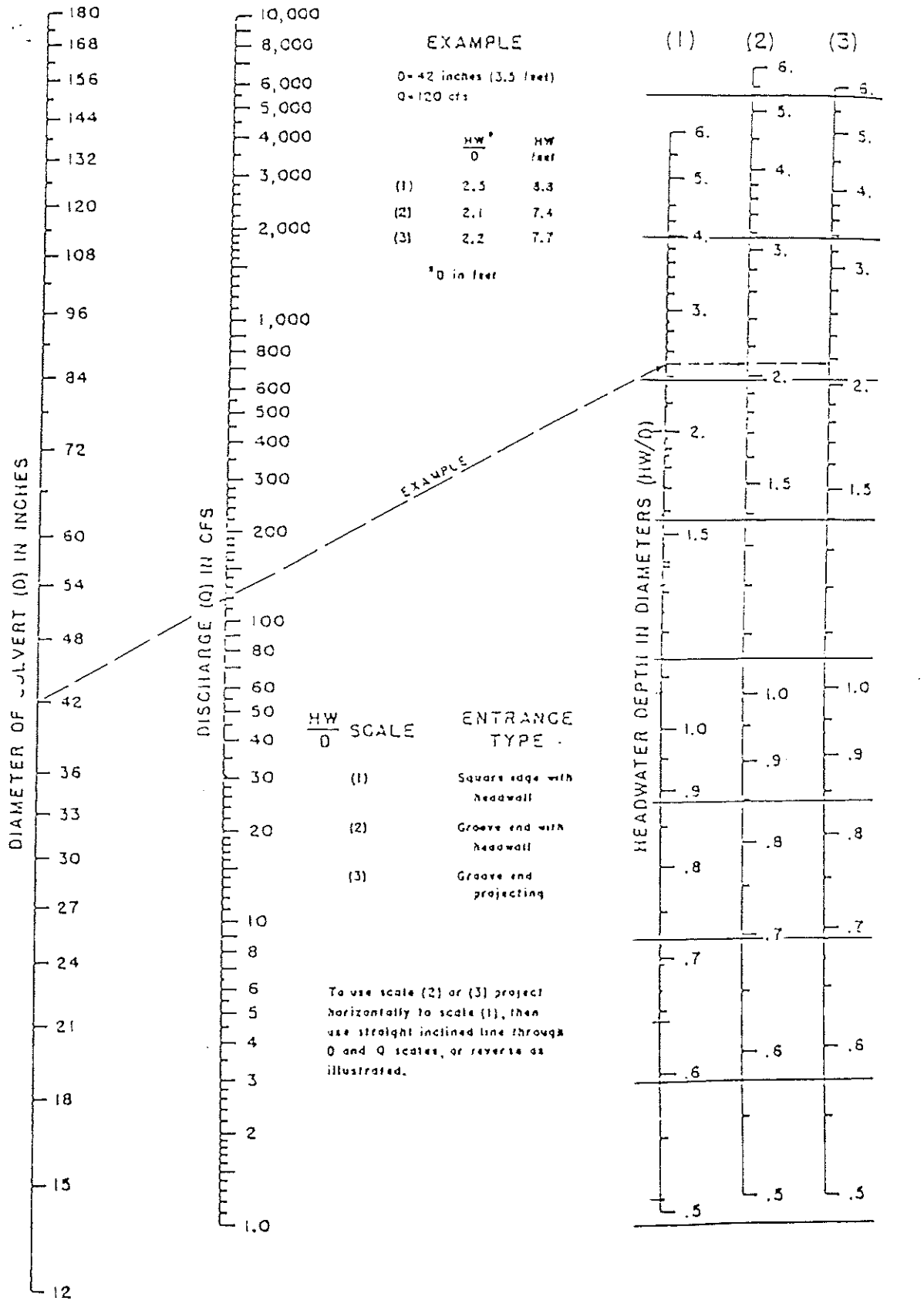
BUREAU OF PUBLIC ROADS JAN. 1963

County of Clay HIGHWAY DEPARTMENT/PWD	HEAD FOR STRUCTURAL PLATE CORR. METAL PIPE CULVERTS FLOWING FULL n=0.0328 to 0.0302
	DC-20

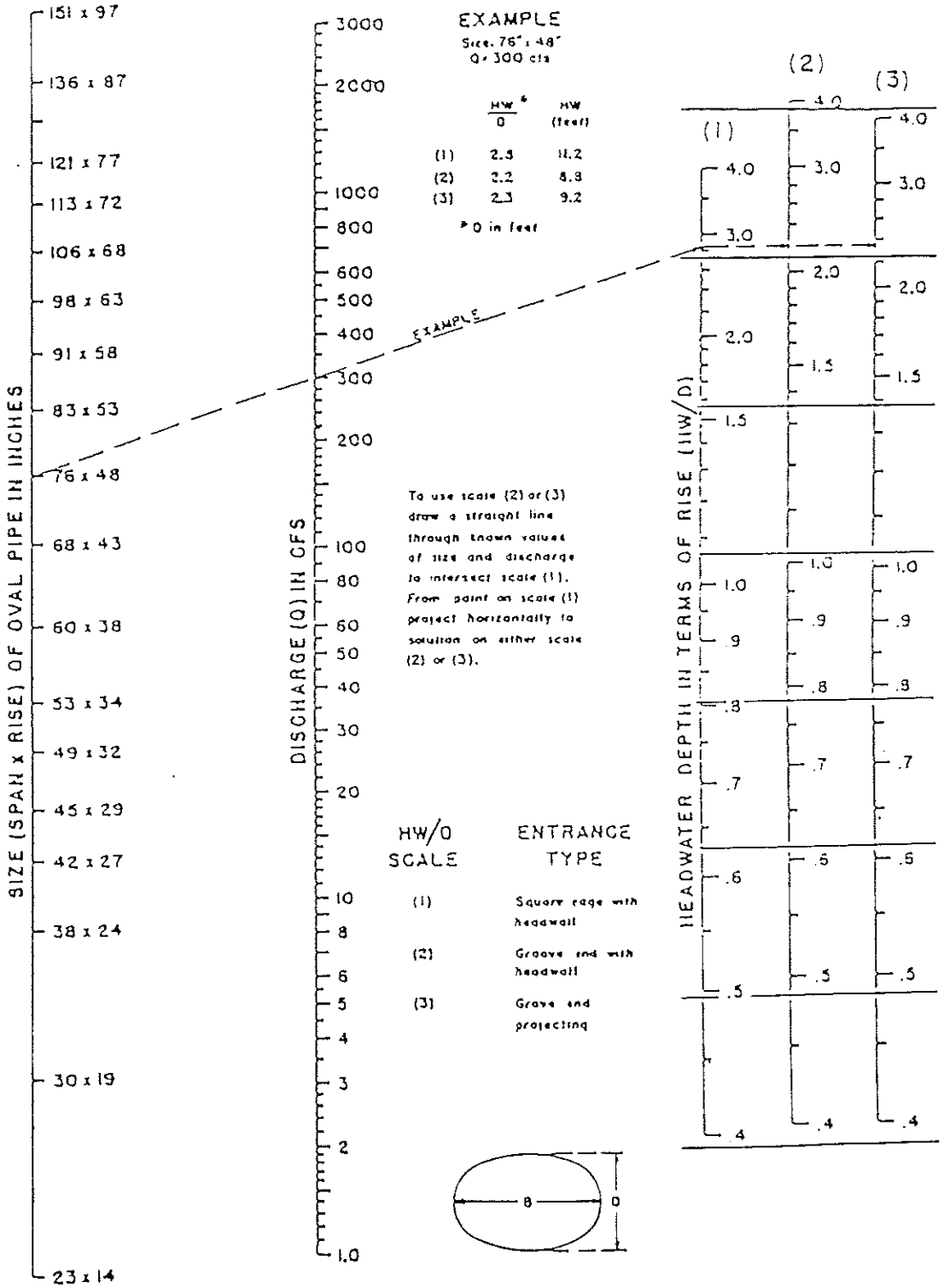


BUREAU OF PUBLIC ROADS JAN. 1963

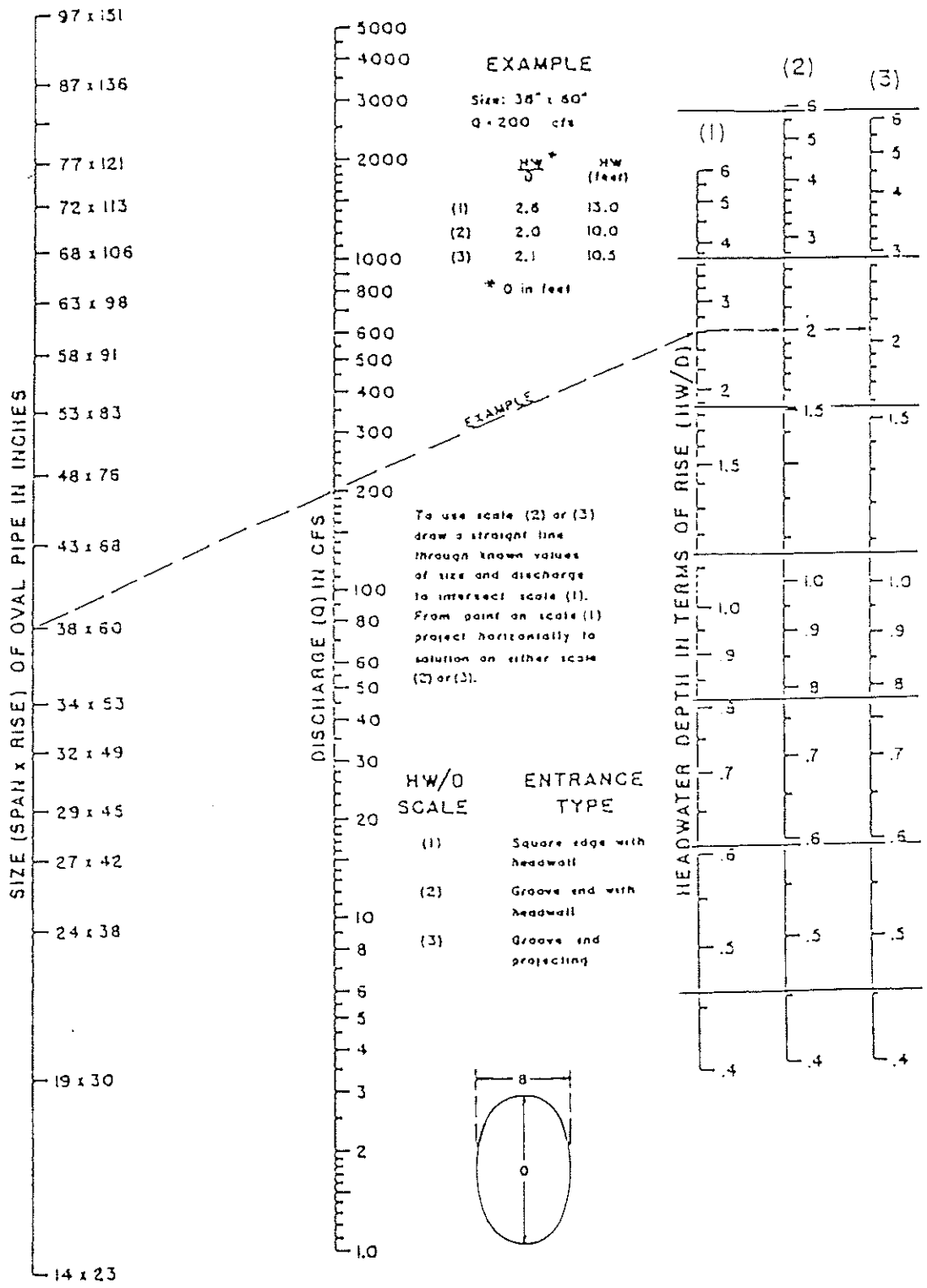
County of Clay HIGHWAY DEPARTMENT/PWD	HEAD FOR STRUCTURAL PLATE CORR. METAL PIPE ARCH CULVERTS 18" CORNER RAD. FLOWING FULL	DC-21



County of Clay HIGHWAY DEPARTMENT/PWD	HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS W/INLET CONTROL	DC-22

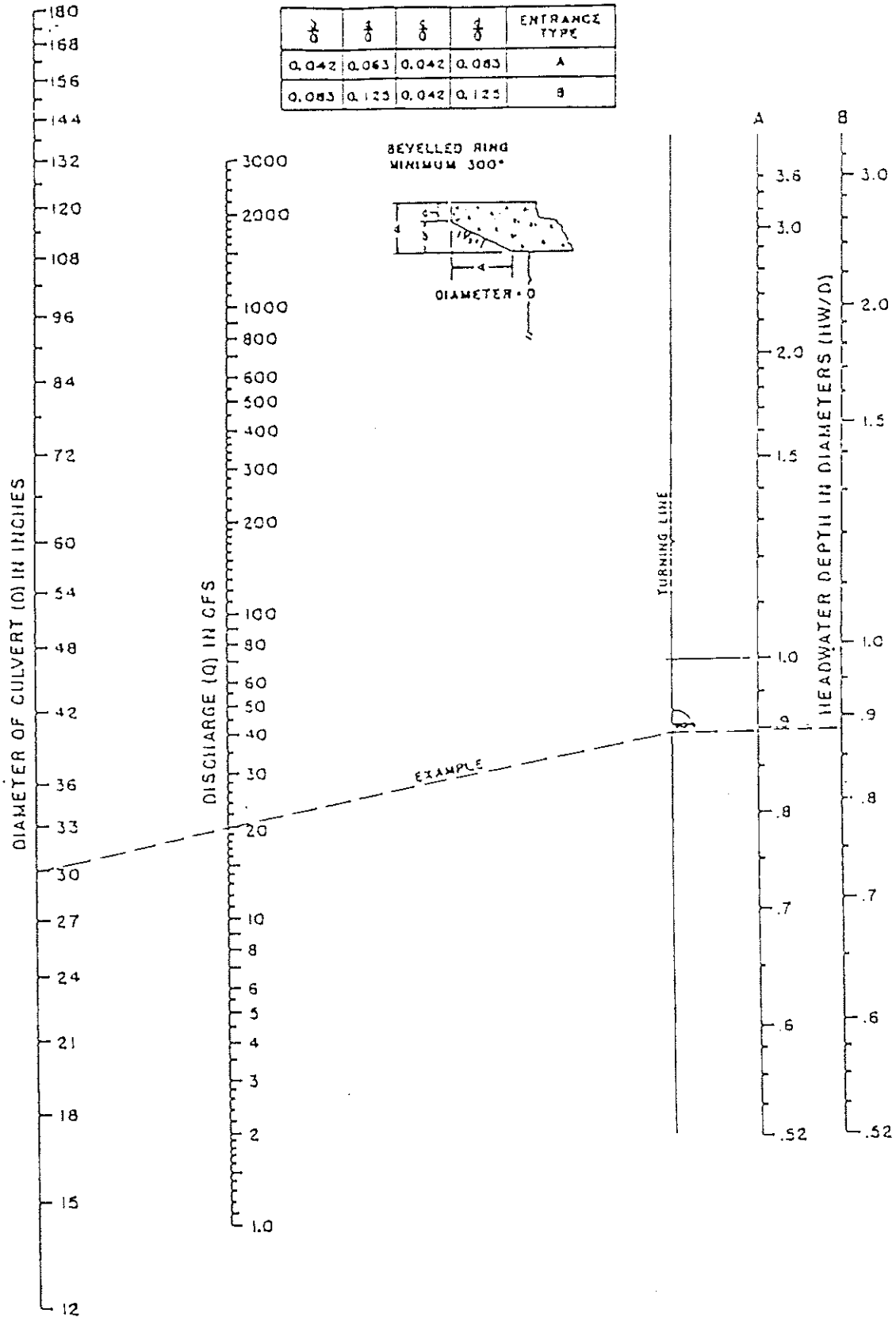


County of Clay HIGHWAY DEPARTMENT/PWD	HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS LONG AXIS HORIZONTAL W/INLET CONTROL	DC-23

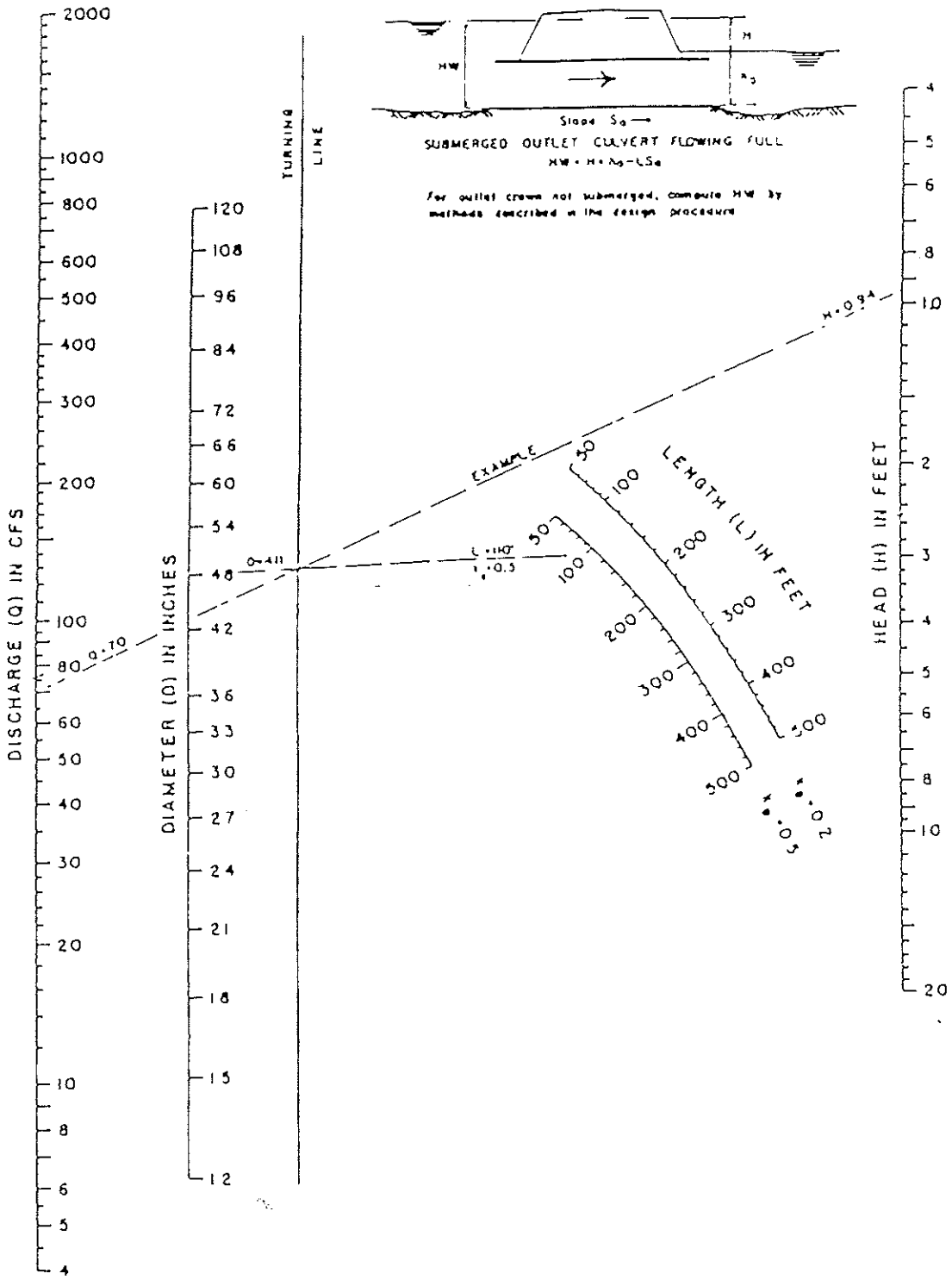


County of Clay HIGHWAY DEPARTMENT/PWD	HEADWATER DEPTH FOR OVAL CONCRETE PIPE CULVERTS LONG AXIS VERTICAL W/INLET CONTROL	DC-24

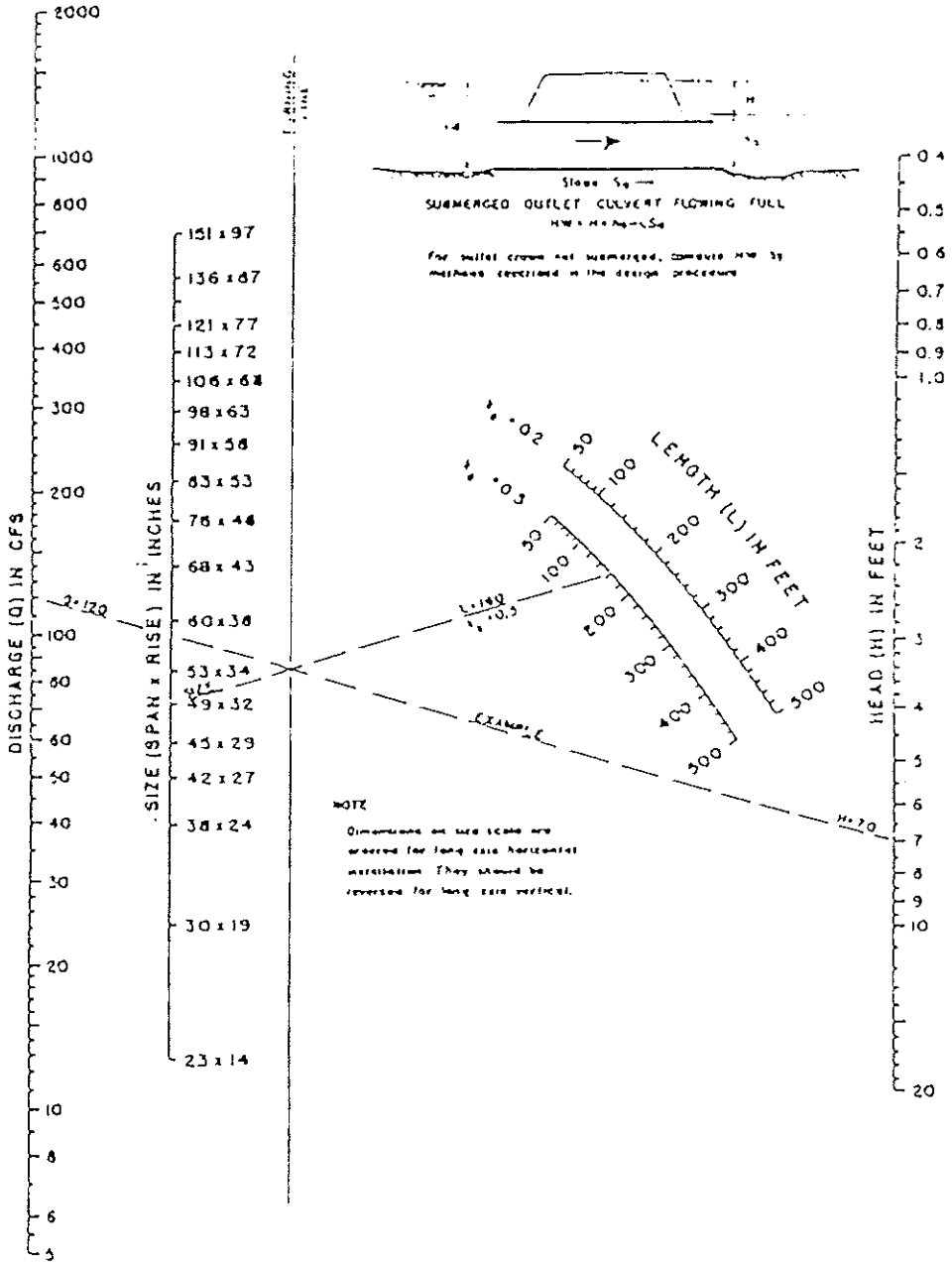
$\frac{k}{D}$	$\frac{b}{D}$	$\frac{c}{D}$	$\frac{d}{D}$	ENTRANCE TYPE
0.042	0.063	0.042	0.063	A
0.083	0.125	0.042	0.125	B



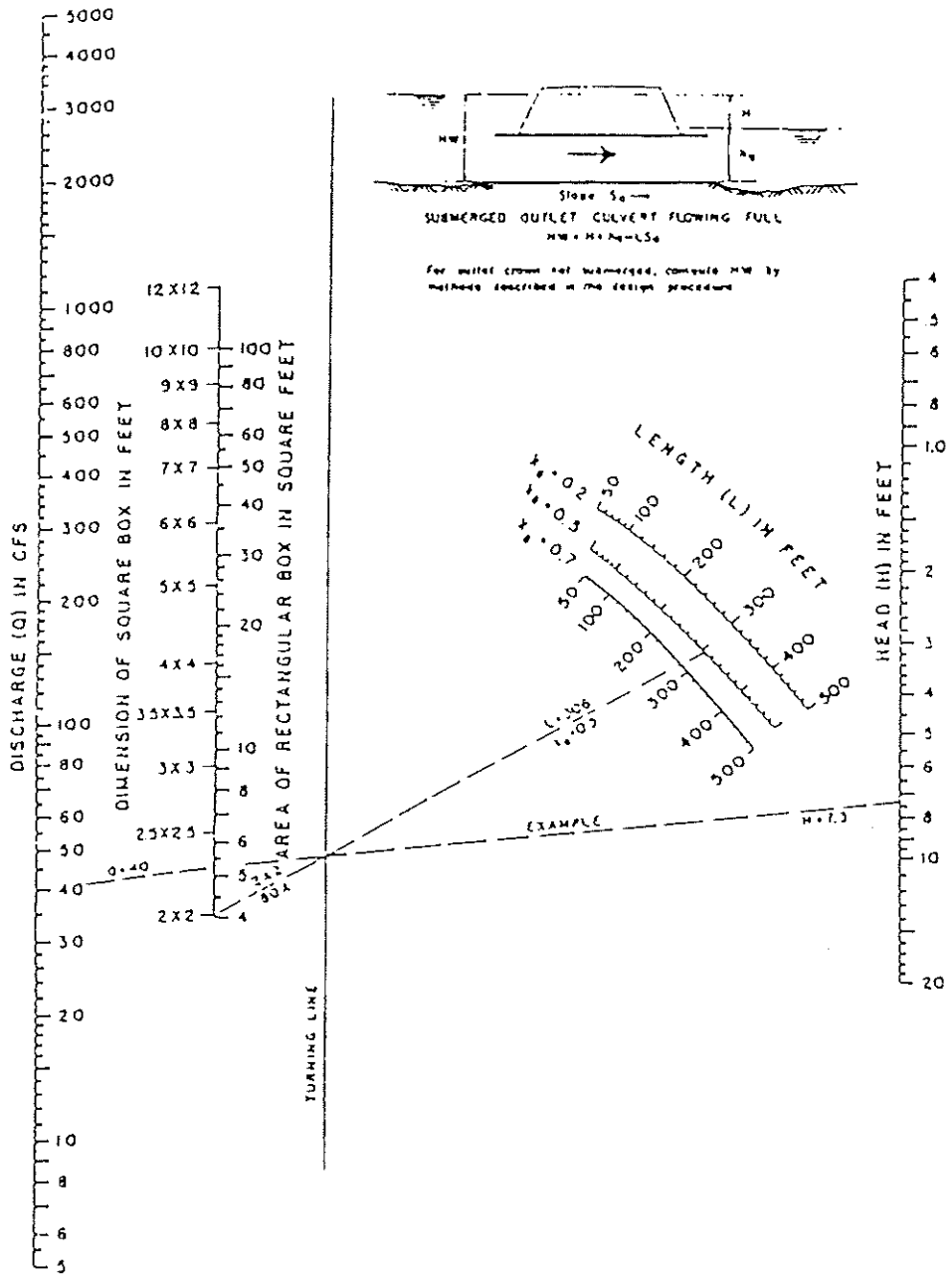
County of Clay HIGHWAY DEPARTMENT/PWD	HEADWATER DEPTH FOR CIRCULAR PIPE CULVERTS W/BEVELED RING INLET CONTROL	DC-25



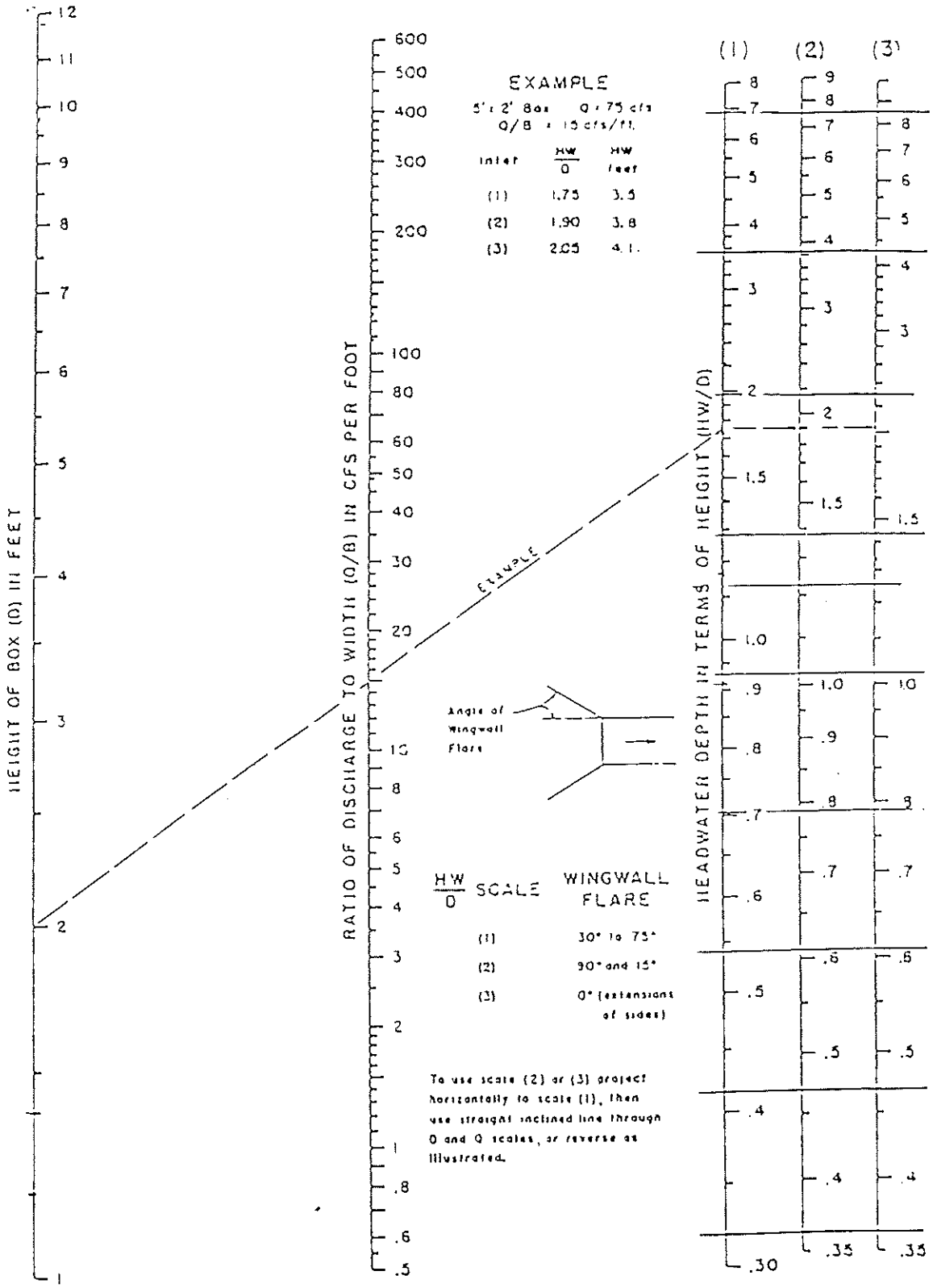
County of Clay HIGHWAY DEPARTMENT/PWD	HEAD FOR CONCRETE PIPE CULVERTS FLOWING FULL	DC-26



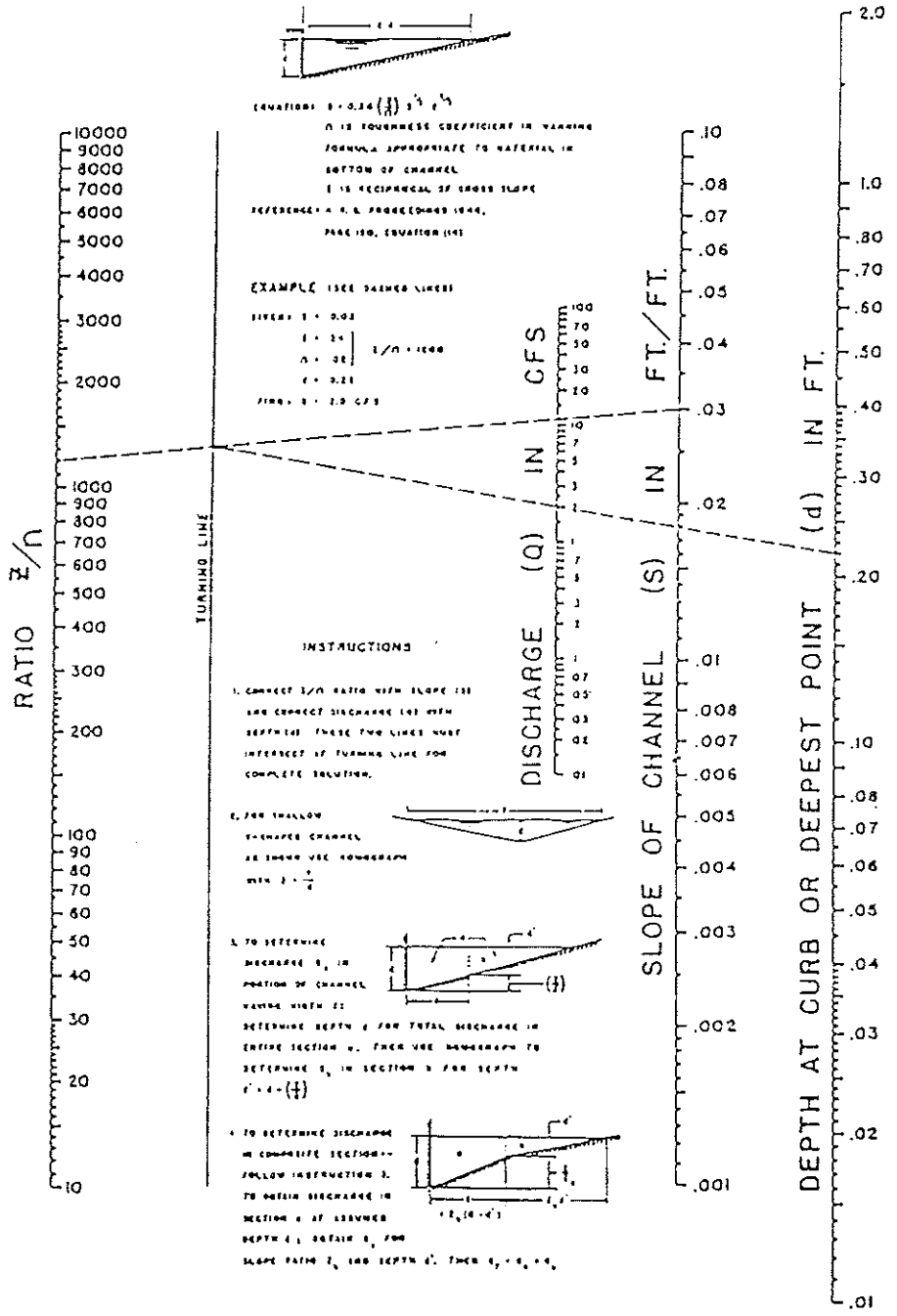
County of Clay HIGHWAY DEPARTMENT/PWD	HEAD FOR OVAL CONC. PIPE CULVERTS LONG AXIS HORIZONTAL OR VERTICAL FLOWING FULL	DC-27



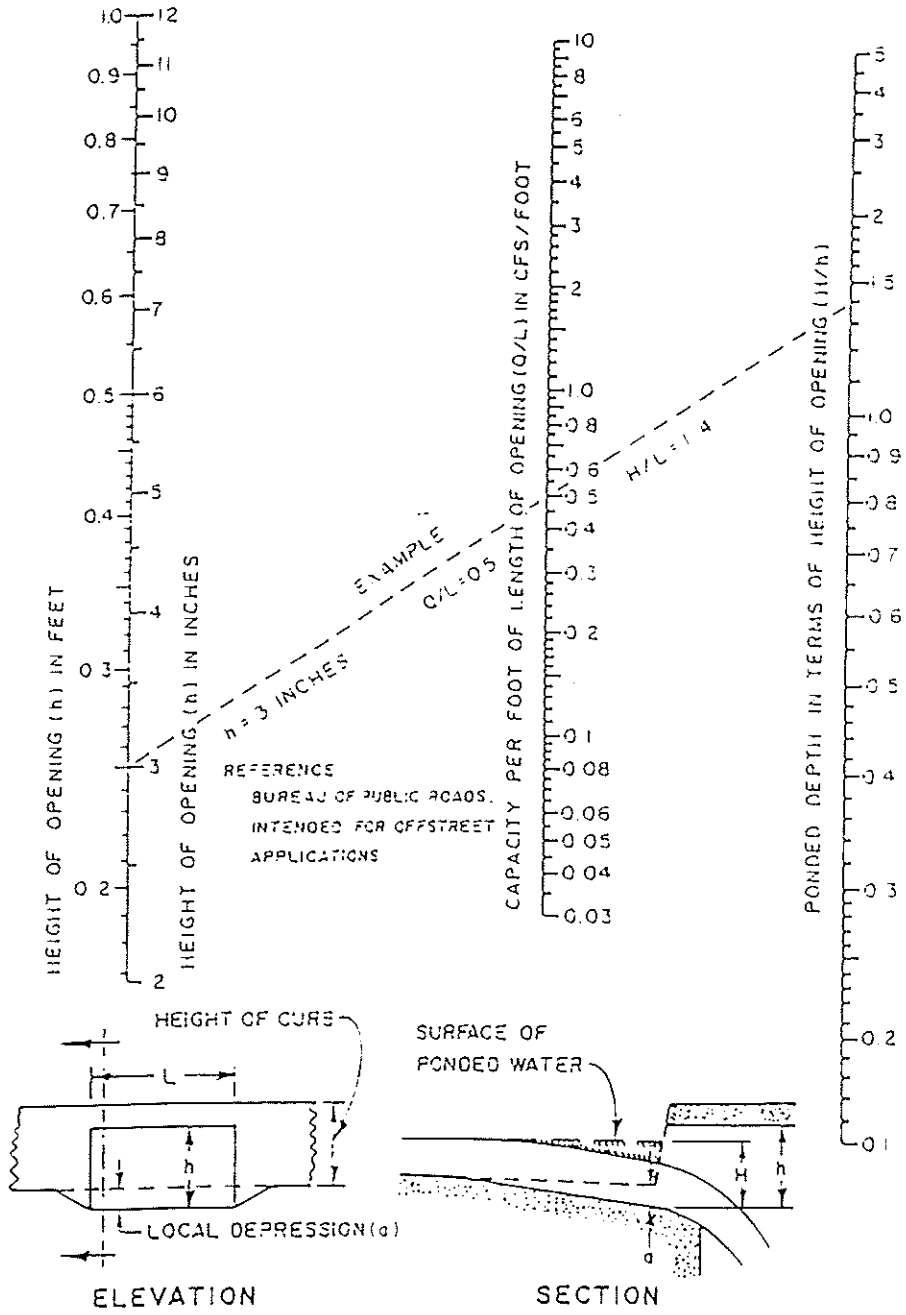
County of Clay HIGHWAY DEPARTMENT/PWD	HEAD FOR CONCRETE BOX CULVERTS FLOWING FULL	DC-28



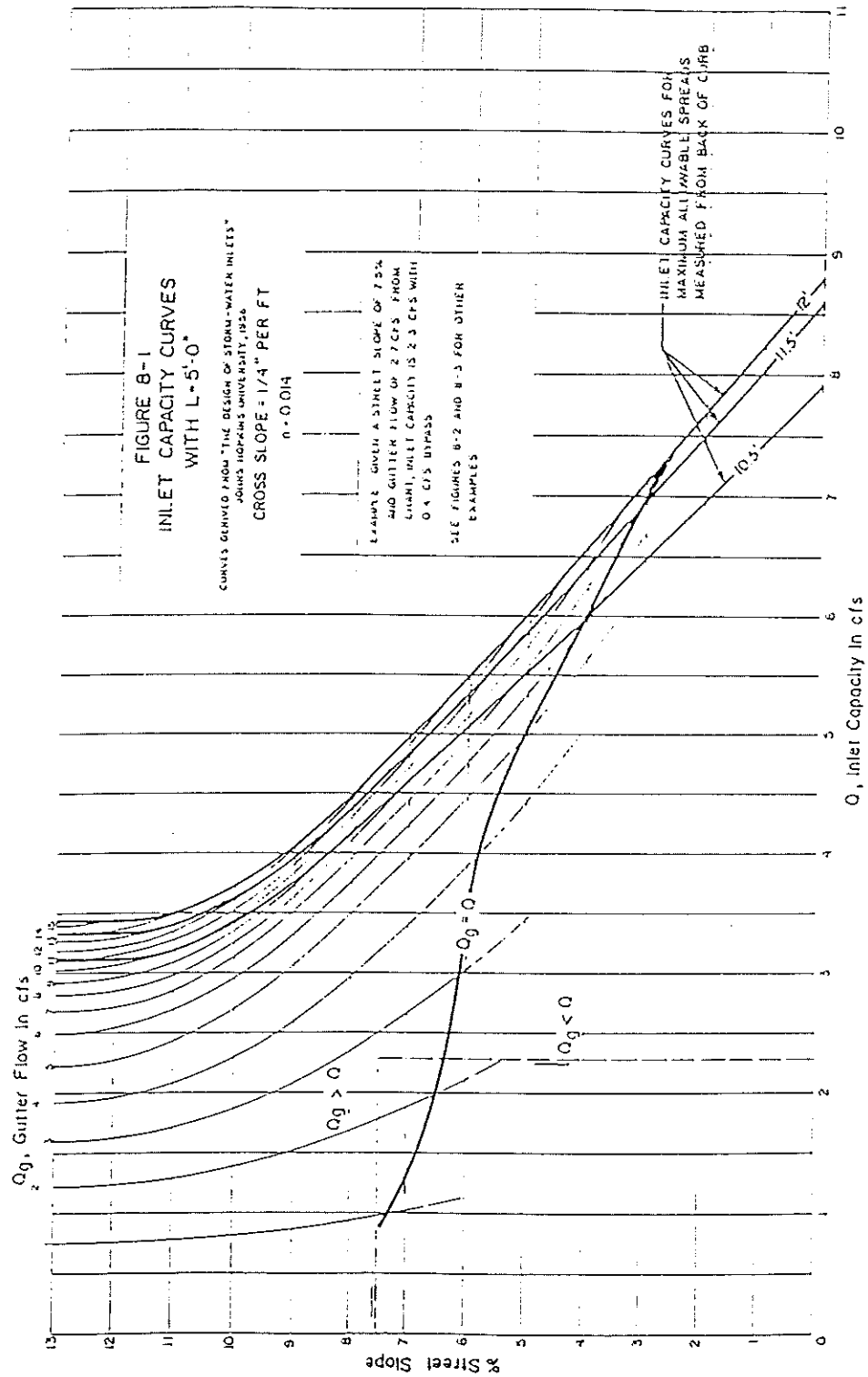
County of Clay HIGHWAY DEPARTMENT/PWD	HEADWATER DEPTH FOR BOX CULVERTS W/INLET	DC-29



County of Clay HIGHWAY DEPARTMENT/PWD	NOMOGRAPH FOR FLOW IN TRIANGULAR CHANNELS	DC-30



County of Clay HIGHWAY DEPARTMENT/PWD	CAPACITY OF CURB OPENING INLET AT LOW POINT IN GRADE	DC-31



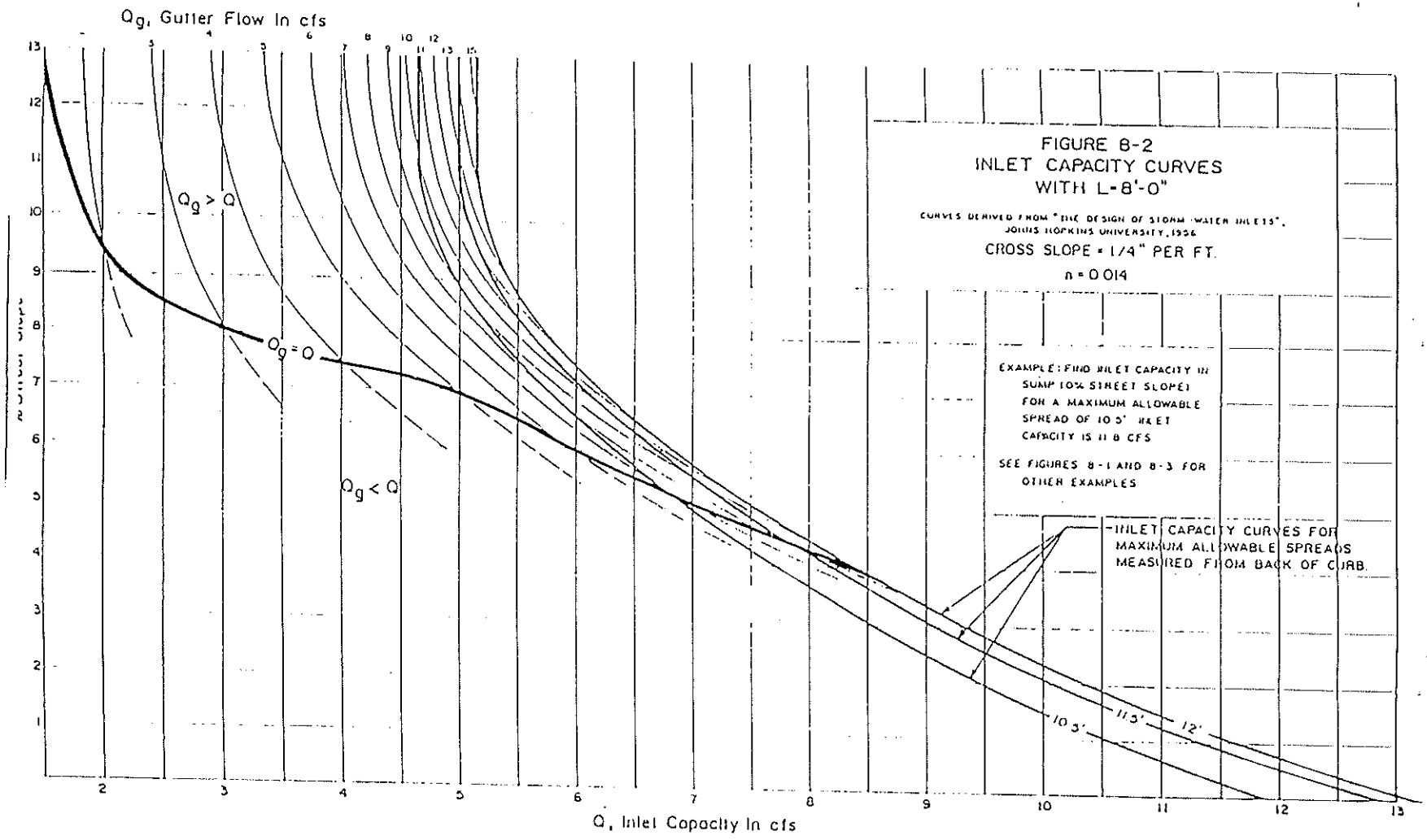
Reduce above theoretical capacities by 20% for clogging allowance per Section 5603.1.B.

County of Clay HIGHWAY DEPARTMENT/PWD	INLET CAPACITY CURVES WITH L=5'0"	DC-32

County of Clay
HIGHWAY
DEPARTMENT/PWD

INLET CAPACITY
CURVES WITH L=8'

DC-33



Reduce above theoretical capacities by 20% for clogging allowance per Section 5603.1.B.

County of Clay
HIGHWAY
DEPARTMENT/PWD

INLET CAPACITY
CURVES WITH L=11'

DC-34

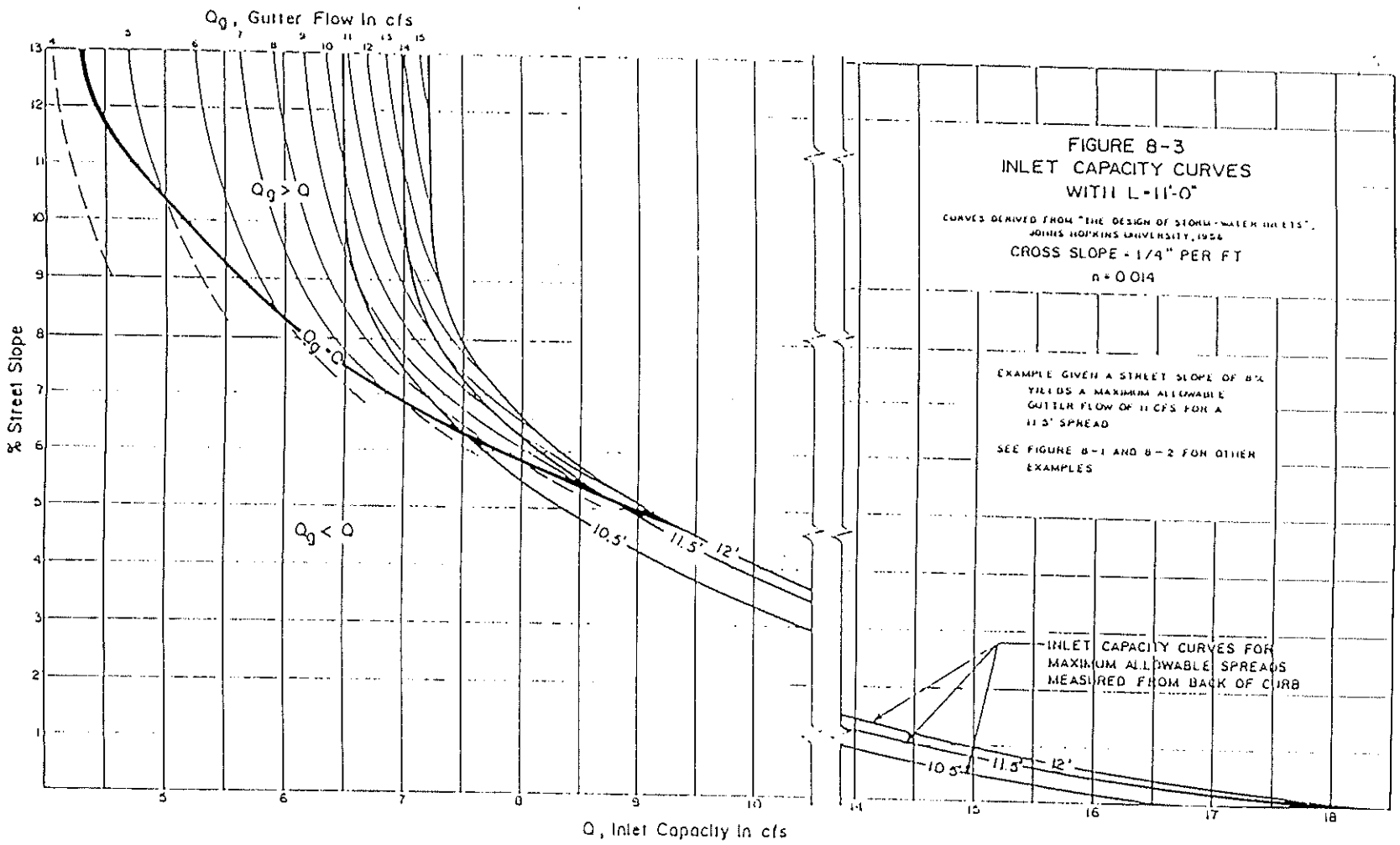


FIGURE 8-3
INLET CAPACITY CURVES
WITH L=11'-0"

CURVES DERIVED FROM "THE DESIGN OF STORM-WATER INLETS", JOHNS HOPKINS UNIVERSITY, 1956

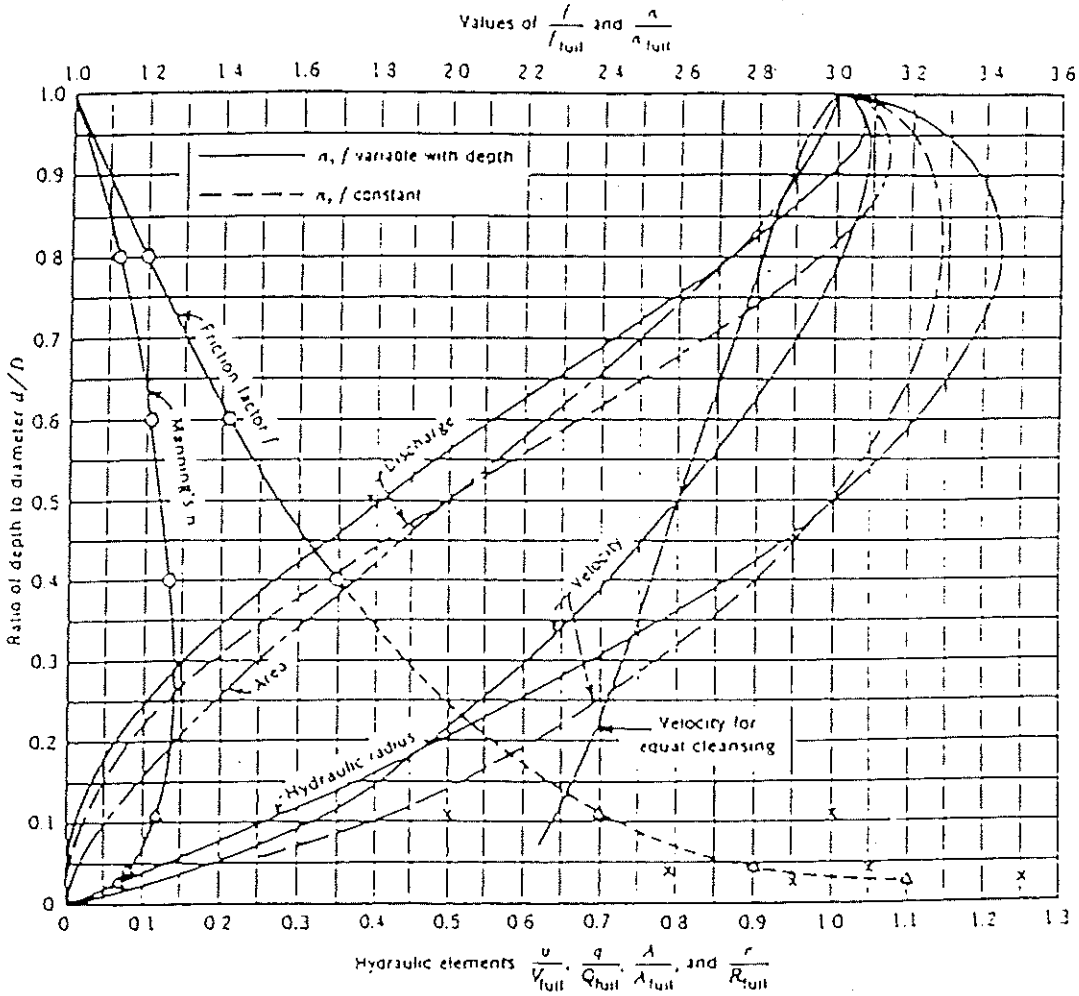
CROSS SLOPE = 1/4" PER FT

n = 0.014

EXAMPLE GIVEN A STREET SLOPE OF 8% YIELDS A MAXIMUM ALLOWABLE GUTTER FLOW OF 11 CFS FOR A 11.5' SPREAD

SEE FIGURE 8-1 AND 8-2 FOR OTHER EXAMPLES

Reduce above theoretical capacities by 20% for clogging allowance per Section 03.1.B.



v : Actual velocity of flow (fps)

V_{full} : Velocity flowing full (fps)

q : Actual quantity of flow (cfs)

Q_{full} : Capacity flowing full (cfs)

A : Area occupied by flow ($ft.^2$)

A_{full} : Area of pipe ($ft.^2$)

r : Actual hydraulic radius (ft.)

R_{full} : Hydraulic radius of full pipe (ft.)

County of Clay HIGHWAY DEPARTMENT/PWD	HYDRAULIC ELEMENT OF CIRCULAR CONDUITS	DC-35